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Empowering Kazakhstan's Energy Future through Smart Technologies

Adaptation of the Strategy& Study "Watt's the plan?"

February, 2024

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Important note

PwC Kazakhstan presents the results of the study “Empowering Kazakhstan's Energy Future through Smart Technologies” as of February 2024. The study is an adaptation of the Strategy& Study “Watt’s the plan?”, which discusses the implementation of digital business models (DBMs) for energy utilities. We have looked at possibilities of DBMs implementation in the context of Kazakhstan, and what kind of challenges our energy system poses specifically.

In the study you will also find the results from our interviews of Kazakhstani experts in EV charging and smart home technologies.

Overall our study reflects:

- The state of the implementation of smart grid, EV charging, and smart home technologies in Kazakhstan as of January 2024
- The views of those interviewed including the current challenges in deployment of these technologies
- Recommendations on actions needed to address those challenges
- Anticipated developments of EV charging market, and smart technologies

Natalya Lim

Partner, Strategy& and Advisory Leader of Eurasia Region

Natalya has broad and extensive consulting experience of more than 19 years. Natalya leads the Strategy & Operations team, Transaction Support practice, Data Analytics team and ESG practice in Eurasia (Central Asia, Caucasus and Mongolia).

Foreword

Annually, at PwC Kazakhstan, we release a study on our Energy sector. This initiative is our independent contribution to fostering a more sustainable and resilient energy system. It holds significant importance for us as we continually explore novel approaches to development of our energy system for our authorities, businesses, and researchers, all working towards a common goal. In 2021, we extensively examined the challenges and opportunities within the Renewable Energy sector. In 2022, our focus shifted to a detailed exploration of the issues hindering the energy transition that must be addressed to achieve our Net Zero objectives.

This year's study, however, is dedicated to the digitalisation of the energy system, reflecting our commitment to understanding and navigating the transformative impact of digital technologies on the energy landscape.

The various industries, including media, retail, and financial services, have already started confronting the digital challenges several years ago, and their lessons learnt indicate that businesses have only two choices: either adapt by incorporating profitable digital business models to create new value for customers or risk losing their market share.

In fact, it's a matter of evolving or facing decline. Fortunately for utilities, amidst the shift towards clean energy, there are significant opportunities in expanding services related to their core activities of energy generation, transmission, or sales. Companies that proactively position themselves in the vanguard of this transformation stand to gain a competitive edge.

The rapid development of Artificial Intelligence (AI) has the potential to even further disrupt traditional business models in various ways, leading to both challenges and opportunities for industries. Companies that successfully integrate AI/GenAI into their strategies and business models can thrive in the evolving business landscape, while those that resist may face challenges in remaining competitive.

Digital business models were analysed by our industry and functional experts from Strategy& team after conducting a survey of more than 300 industry experts across the utilities' value chain, predominantly in Europe, about their expectations for digital transformation, their progress in adding new products and services, and the factors holding back change.

We customised this study with the aim to scrutinise how well-aligned we are with these global trends in Energy and Utilities within our local landscape. This introspective analysis, a cornerstone of our annual publications, delves into the current situation and challenges confronting our energy system. We hope that the invaluable insights gained by our team will not only be acknowledged but also propel authorities and businesses to be proactive in embracing and adapting to the ever-evolving global trends in the sector.

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Overview, objectives and conclusions of the study

This publication was developed as an adaptation of the Strategy& study "Watt's the plan?" ("the Study"). The original Study was created in collaboration between Strategy&, PwC's global strategy consulting business, alongside PwC industry and function experts. The Study elaborates on the opportunities and challenges for digital business models (DBMs), where the greatest potential for synergies with the core business lies, and how to build necessary capabilities. The team working on the Study surveyed more than 300 industry experts in Europe about their expectations for digital transformation, their progress in adding new products and services, and the factors holding back change.

Expanding on this Study, we have examined the current state of smart technologies, namely, smart grid, EV charging and smart home, in Kazakhstan. Our analysis examines the gaps in the current implementation of these technologies into the energy systems and delves into the challenges to their digitalisation. Based on our review, we identified factors hindering adoption of smart technologies and offer recommendations to address these challenges and potentially streamline the deployment of smart technologies, contributing to the overall advancement of Kazakhstan's energy sector.

"Other industries already leverage digital business models to understand their customers better and offer improved services. Energy companies must urgently digitalise their business models to meet customers' higher expectations beyond just selling kWhs and stay competitive in the longrun."

Prof. Dr. Norbert Schwieters,
World Energy Council board member

Data analysis approach and interviews results

The study is an adaptation of Strategy& study "Watt's the plan?" and includes selected excerpts from the original Study. It also includes analytical data from open sources on smart grid, EV charging and smart home technologies, and the level of their implementation in Kazakhstan.

More specific sources are mentioned below.

Overview of the smart grid technologies:

- Kazakhstan's Smart Grid Concept[1];
- Smartgrid.gov website;
- Agora-Energiewende website;
- Codibly website.

Overview of the EV charging infrastructure in Kazakhstan:

- AIFC report on EVs in the world and in Kazakhstan, and their role in reducing GHG emissions;
- Report of RMI: X-change: Cars. The end of the ICE age;
- Official websites of eDrive.kz and Operator EZS;
- Interviews.

Overview of the smart home technologies:

- Statista Market Insights;
- Scholarly articles;
- Tech of Brazil website;
- Interviews.

Interviews conducted with experts in EV and smart home industries in Kazakhstan were the crucial input for our study. They were asked to share their views on the prospects and challenges of the implementation of these technologies in Kazakhstan, as well as suggest recommendations for their further development. The results are presented in an aggregated form. Individual comments from respondents in Kazakhstan were disclosed in our study with the permission of the respondents.

Interviews in Kazakhstan were conducted between October and December 2023. The insights from the interviews are presented throughout the study.

Note that the opinion of the interviewed experts may reflect their own position on certain issues, and not the position of the company / department where the respondents work. Also note that at the date of release of this study, information on the place of work and position of our respondents may not be relevant due to time lapse since the interview.

Sources: [1] Gov.kz, 2023.

1. New value potential of digitalisation and digital business models

1.1. Digitalisation creates financial opportunities

What is a digital business model and how does it create value?

Digital business models give value to private and commercial consumers and expand potential profit pools for companies through new technologies including artificial intelligence (AI), the Internet of Things (IoT), cloud computing and energy analytics.

It creates additional revenue streams and competitive environment to drive the development of these technologies

The perceived value generated by the DBM determines a customer's willingness to pay for a product or service, for reasons including quality, convenience, innovation, and experience. For companies, the benefits come down to the profit potential, looking not just at revenue streams, but also cost savings and optimisation from offering a specific product or service.

Digital technologies are the enabler of the value and profit pools, making them a necessary requirement – but they are not sufficient on their own. It is through synergies with traditional business models that utilities will create the greatest advantage. A good example are smart meters: the devices measure energy consumption and enable live data tracking and direct communication between the consumer's home and the utility. The two-way communication enables flexibility and lets companies make use of dynamic pricing by showing consumers when prices are lowest, so they can adapt their electricity use to take advantage of lower prices. This keeps bills down for consumers and reduces the need for utilities to invest in expensive energy storage solutions to capture the energy generated by renewable sources. This is because demand can be better matched to the times when wind and solar power are being generated.

> "The energy company's core business is selling energy products and services. Digital business models may improve the firms' cost efficiency or facilitate more energy sales, and thus provide synergies to the core business. It is, however, important to understand that no digital aspect will replace the core business of selling energy entirely."
>
> **Prof. Dr. Norbert Schwieters,**
> **World Energy Council board member**

Smart digital business models, whether it is smart meters, smart home or smart grid all make demand more flexible by enabling to shift electricity consumption into periods and/or locations where volatile renewable energy production is high.

Smart Grid

The smart grid leverages IoT, AI, and big data for efficient grid management. Smart grid provides real-time monitoring, outage detection, and predictive maintenance to grid operators. The value is to facilitate the integration of renewable energy and distributed energy resources into overall power supply at minimal grid expansion investment costs.

With smart metering, utilities accurately collect real-time energy data from homes and businesses, using applications for centralised reading and usage tracking. This creation of transparency is crucial to enable shifts in consumption in the first place.

Profits from smart grid come from lower maintenance costs and grid stabilisation fees. Another profit stream is to monetise the benefits of providing flexibility to the energy system.

Thirdly, data can also be monetised, yet monetisation models are far from being deployed in a large-scale way, as data access and quality remain a major issue in many large utilities.

Example: The dutch platform GOPACS offers actual payments for demand/ production shifts that reduce congestions in the electricity grid.

> The very first step in data monetisation is data access and quality, which remains a major hurdle for large energy companies, making the process of monetisation burdensome right from the start."

Flore de Durfort,
CEO at Point Twelve (German SaaS platform to certify green production processes) and former head of data incubation & monetisation at E.ON (major German energy supplier)

The synergy potential of smart meters

An example of synergy potential between DBMs and the core business are smart meters that enable dynamic pricing. General Electric, for instance, offers a demand-side resource and response management solution with which energy companies can incentivise consumers to adapt their behaviour. The goal for the utilities is to achieve more efficient operations resulting in lower prices and cost savings for customers. Smarter demand management also means deferred capital expenditure in generation, transmission and distribution, and helps utilities to increase reliability, with fewer outages and lower ancillary service costs related to renewable energy integration.

The survey looked at the relevance – defined as the potential for revenue generation in future – of a range of DBMs, and identified EV charging and smart DBMs such as smart metering and smart grid, as most relevant, because of the synergy potential with the core business. Some 56 percent of respondents rated such synergies as the primary driver of relevance.

Electric vehicles charging

Providers offer comprehensive electric vehicle charging solutions and services and generate revenue through pay-per-use or subscription models. Digital technologies are used to provide customers with real-time charging information, reservation systems, and demand-response charging.

The value the service offers to electric vehicle users is convenience, through accessibility and fast charging. For utilities, it is also an opportunity to enhance grid stability by encouraging off-peak charging and reducing load during peak hours.

The profit pool lies in the installation and operation of the EV charging infrastructure: Utilities can install and operate charging stations in public spaces, commercial properties, or private homes. EV owners are billed for charging, creating a recurring revenue stream. For instance, the US utility PG&E has programmes to help businesses install charging stations, and they earn revenue through the charging tariffs. Starting partnerships with EV charging networks like ChargePoint or Blink Charging denote one possibility to earn revenue from charging fees.

Example: In Copenhagen the power company Enel has established a “vehicle to grid” hub in a partnership with Nissan and Nuvee, an EV charging company, in which the power stored in EV batteries can be fed back into the grid when the vehicles are not in use and demand for power is high.

> “Connecting EVs to the grid has the potential to disrupt the entire energy system. Firstly, the European car fleet electrification creates a vast shift from gasoline to electricity demand yielding revenue opportunities for utilities. Secondly, utilising the EVs’ battery capacity for grid stabilisation, i.e. off-peak charging incentives, decreases the need for grid expansion and adds thus a unique value to the energy system.”

Andreas Hoffknecht,
Technical director Deutsche Bahn Energy (subsidiary of Deutsche Bahn AG)

Smart homes

Smart homes, which include smart buildings and elements of the smart city, use IoT to integrate energy management solutions. Digital twin technology is used to simulate and optimise energy usage scenarios in buildings, while AI and machine learning (ML) are used for automation and to prompt adaptations in user behaviour in systems such as lighting, heating and cooling.

In addition to enabling energy management, IoT technologies in smart homes contribute to enhanced security, comfort, and the overall health and well-being of users.

The profit pool for smart meters and smart home devices is generated firstly by hardware sales or leasing. Utilities can sell or lease smart meters to their customers, billing them for the device or a recurring lease fee, while in smart homes, utilities can sell smart thermostats, smart lights, and other IoT devices, billing the end users.

The integration of smart home technologies introduces a crucial sustainability dimension by reducing energy consumption, lowering greenhouse gas emissions (GHG), and promoting the use of clean energy sources. Notably, smart home technology allows for the seamless integration of Renewable Energy Sources (RES) and Distributed Energy Resources (DERs), leveraging IoT predictions and controls to manage their intermittent availability effectively. Furthermore, the incorporation of electric vehicles into the home energy mix is facilitated by IoT, enabling optimal scheduling for charging and discharging[2]. Upgrading the existing metering infrastructure can lead to a substantial 20-25% improvement in energy efficiency[3], while the insights gained from smart home integration into consumption patterns can yield energy savings of 5% to 50%[4].

Case study: Ison Energy

Ison Energy's smart home energy management system monitors households' energy consumption and production in real-time, improves inefficiencies by task automation and enables household to benefit financially by selling their energy back to the grid and participating in demand response programmes. On top, Ison Energy's technology can be integrated into other businesses' products and services, offering customers more sophisticated energy management solutions.

Ison Energy's commitment to open source, community, and education is helping to create a more sustainable and efficient energy future. As utilities continue to embrace digital transformation, companies like Ison Energy are leading the way in creating new value for customers and generating new revenue streams.

> Smart meters are essential to enable a transparent, bi-directional communication between consumers and utilities. This helps utilities understand their customers better and, more importantly, enables immediate customer responses, which has been historically one of the most serious market frictions in the energy system."

Constantin Eis,
CEO at LichtBlick SE (major German energy supplier)

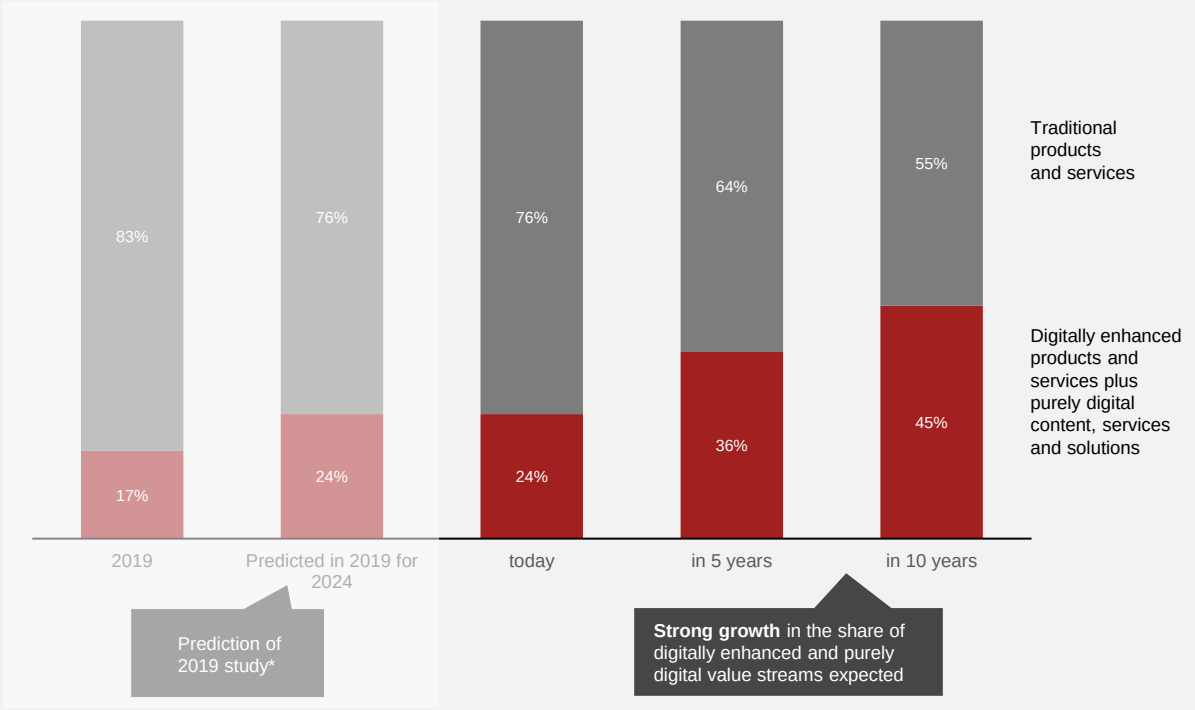
Sources: [2] Satuyeva et al., 2019. [3] PwC India, 2022. [4] Connected Home.

1.2. Digital business models can unleash new value by complementing the core business

In 2019 study by Strategy& on digital business maturity among utilities companies in EMEA, respondents forecasted that digital business models would account for 24 percent of revenue by 2024 – an accurate prediction as DBMs have reached that proportion this year. Looking ahead five and ten years from now, DBMs are expected to account for 36 percent of revenue by 2028 and for 45 percent by 2033 in the same region (*see Exhibit 1*).

To double the share of revenue from digital products and services as expected over the next decade, power companies must transform urgently. That doesn't mean abandoning traditional products and services but rather digitalising them to establish high-margin and scalable DBMs.

EXHIBIT 1
Expected share of business from DBMs in the future



*2019 Digital Operations study for energy – Power and utilities. PwC Strategy&
Source: Strategy& analysis

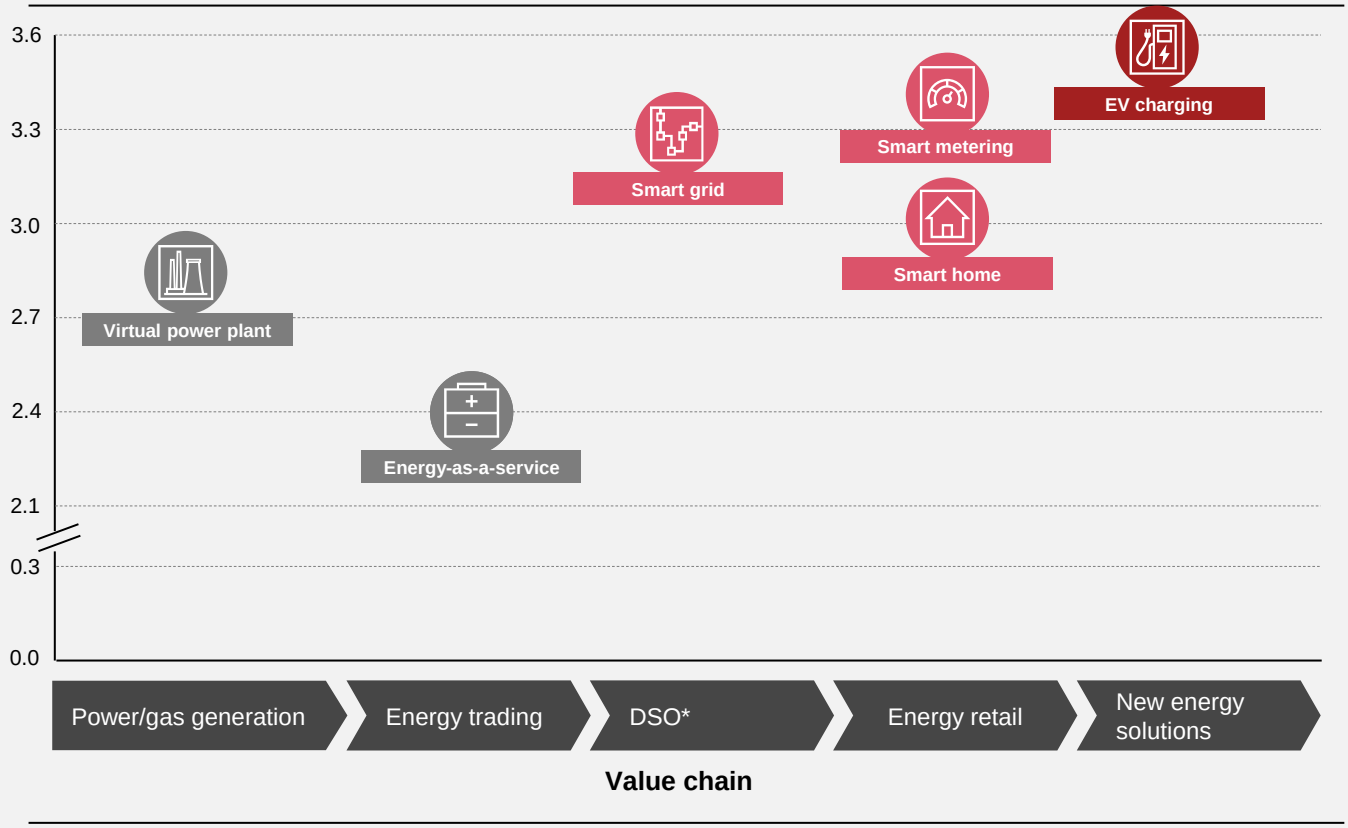
The urgency of digital transformation: Utilities as the next Blockbuster?

In 2000, Netflix was a two-year old company mailing DVDs to people who ordered them online. The fledgling business was losing USD 57 million a year and approached Blockbuster, then a video rental giant with 9,000 stores around the world, about a potential sale. The proposed deal included Netflix's founders setting up an online movie rental business for Blockbuster. Blockbuster's CEO John Antioco turned the deal down. Ten years later, Blockbuster had declared bankruptcy because it never successfully kick-started a digital business, while Netflix has gone on to become a media and entertainment giant.

Interestingly, the DBMs EV charging and smart DBMs, such as smart metering and smart home, are both located toward the consumer-facing end of the value chain (*see Exhibit 2*), i.e., the DBMs must inherit a clear value add for consumers. The value add from EV charging is obvious – EV charging is key for e-mobility. The consumers' value add from smart DBMs are financial benefits: smart meters and smart home can deliver their full value add if and only if instant pricing provides financial incentives to which households adapt making them thus better off. Lastly, smart grid decreases the energy system's costs (lower redispatch and grid expansion costs) from which grid operators benefit financially and hence households in the long run too.

EXHIBIT 2

Relevance of DBM along the value chain



Note: *DSO – Distribution System Operator
While most DBMs touch on multiple value chain steps, in this case the classification by value chain step was done heuristically
Source: Strategy& analysis

The level of adaptation of digital business models for utility companies depends on factors such as regulatory environment, market structure, and the specific challenges faced by each country. Adaptation of regulations and policies to accommodate new digital business models and technologies has enabled European utility companies to meet challenges and opportunities presented by the changing energy landscape. While experimenting with different digital solutions these companies gained significant knowledge and understanding of the relevance of a wide variety of digital tools and solutions, such as virtual power plant or a digital twin. However, utility companies in Europe still face gaps in the implementation of critical elements of an advanced and efficient energy system.

For Kazakhstani businesses and authorities, experience and insights that were acquired over time and through dedicated efforts by European utilities can serve as a valuable compass, helping them discern relevant solutions without incurring significant expenses of implementing irrelevant measures. By examining western regulatory framework and market structure, we can anticipate market and regulatory changes, tailor previously tested solutions to Kazakhstan's unique context and create opportunities for the successful implementation of smart technologies.

2. Implementation gaps and recommendations in Kazakhstan

2.1. Exploring the implementation gap in digital business models: Kazakhstan

In alignment with the Strategy& Study, we conducted an analysis focusing on the relevance and implementation status of smart technologies, EV charging, Virtual Power Plants and Energy-as-a-Service. Given the notable variations in the adoption and maturity levels of these technologies between the EU and Kazakhstan, their impact and relevance in Kazakhstan was evaluated in relation to the grid development, rather than commercialisation opportunities.

Thus, 'relevance' refers to the practical assessment of the integration of these technologies into the Kazakhstan's energy sector, considering its current development state and technologies' pivotal role in fostering the robust development. The 'implementation gap' refers to the existing level of implementation of these technologies in the country. Thus, in Kazakhstan, existing infrastructure limitations, a regulatory framework that lags behind technological requirements, and limited investments result in the 'implementation gap' for each technology that is distinct compared to the developed markets (see *Exhibit 3* on the next page). The assessment of each technology's 'relevance for development' is elaborated upon below.

The proliferation of **smart homes** depends on the network development and implementation of smart systems at the grid level. As interest in the 'prosumer' concept grows, the significance of smart home technology amplifies. The technology enables households or entities to engage in both electricity consumption and production, offering economic benefits and a crucial role in regulating electricity consumption and developing demand response strategies.

Smart meters play a pivotal role in enabling more effective monitoring and control due to their capability for real-time data gathering, making them pertinent to grid automation. However, their implementation hinges on the existence of sufficient data centers, which are yet to be established.

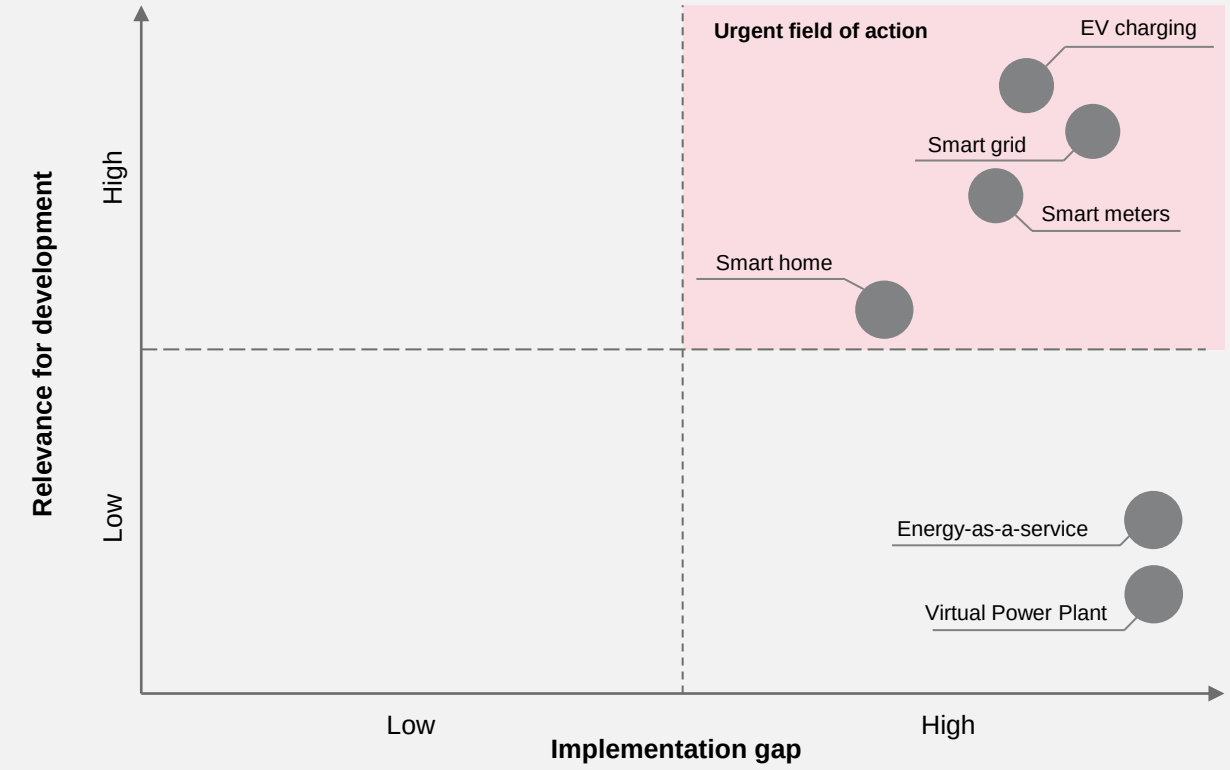
Installation of **EV charging stations** poses a challenge due to the anticipated high electricity demand, surpassing the current power capacities. To address the expected surge in electricity requirements and alleviate potential deficits, the system operator is constructing additional grid lines from the northern region to meet the escalating demand in the south. Despite these challenges, rapid growth of EVs means it will be essential to expand the number and the network of charging stations to meet the demand.

Smart grid implementation is crucial to the development of the energy sector as it offers numerous benefits, including enabling real-time data analysis, integration of renewables, and empowering consumers to make informed energy choices, ultimately fostering efficiency, reliability, and sustainability in energy distribution. It is vital for modernising energy infrastructure.

Virtual Power Plants and **Energy-as-a-Service** technologies' implementation would be pertinent in case of advanced level of smart grid deployment and automation. Current relevance to the development of the energy systems is thus limited, as these concepts are relatively innovative and are not widely known in Kazakhstan. Further education in these technologies might be required.

EXHIBIT 3

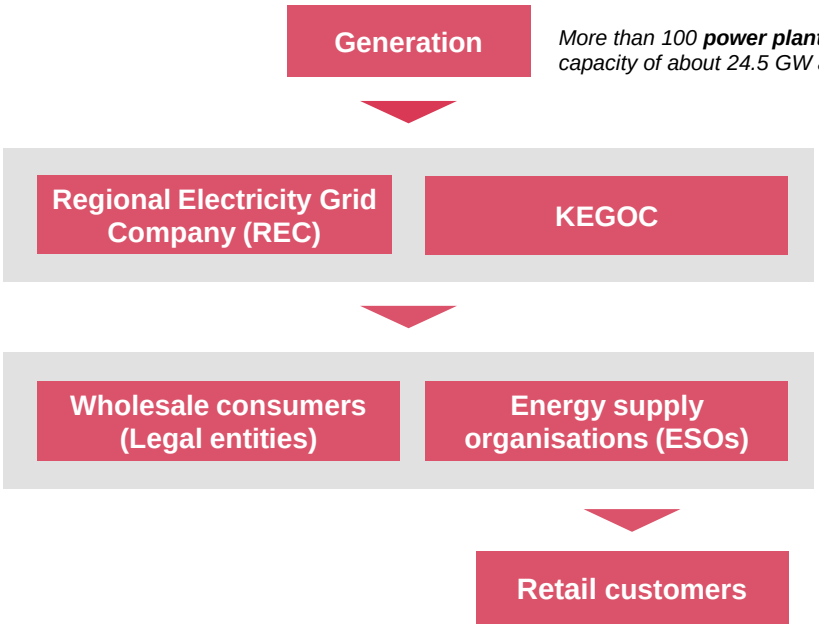
The implementation gap in Kazakhstan



Source: PwC analysis

2.2. What is the current situation with deployment of three major technologies in Kazakhstan?

Currently, Kazakhstan's electricity grid follows a traditional model with centralised generation and a one-way flow of electricity, i.e. there is no “prosumer mechanism” implemented. The national grid operator, KEGOC, is actively working on incorporating **smart grid technologies** to modernise the energy system.[5] However, the implementation of these technologies is still in its early stages, with pilot projects and initial efforts showing potential improvements in efficiency and reliability.[6] Despite KEGOC's progress, distribution companies (RECs) throughout Kazakhstan face challenges in keeping up with the adoption of smart grid technologies. The limited integration of advanced metering infrastructure (AMI), grid automation, and demand response programmes among these entities highlights the early phase of smart grid development in the country. Additionally, the regulatory framework has not fully adapted to support this transition, leading to inefficient adoption rates and a lack of standardised practices that could guide the development of a more resilient and responsive grid infrastructure.



*More than 100 **power plants** with different forms of ownership, total installed capacity of about 24.5 GW and available capacity of 20.7 GW (2023)[7]*

***KEGOC** - **System Operator** operator of the national electric grid, provides electric connection between the country's regions and power systems of neighbouring countries*

***RECs** - **Distribution Companies** provide electricity connection within regions, as well as transmission of electricity to retail consumers*

***Wholesale consumers** and **energy supply organisations (ESOs)** that purchase electricity directly from energy producing organisations under bilateral agreements or on the centralised electricity market and then sell it to retail consumers.*

Sources: KEGOC Annual Report 2022, Ministry of Energy of the Republic of Kazakhstan, open sources, PwC analysis

We observe a similar pattern of developmental challenges in the deployment of **EV charging infrastructure**. EV charging stations are unevenly distributed, primarily concentrated in two major cities. In contrast, the rest of the country typically has fewer than five stations per city. Taking into account the considerable distances between cities, it is essential to install charging stations along highways, but their numbers are currently insufficient. Low demand for EVs is impeding the natural development of charging infrastructure and the absence of established standards and regulations for charging stations poses an obstacle to their effective implementation.

In contrast, **the smart home** and IoT market in Kazakhstan is robust, driven by a sizable demand for technologies covering security, comfort, lighting, smart appliances, control, connectivity, energy management, and home entertainment. While the sector shows significant growth potential, with an increasing number of active households and a preference for enhanced convenience and security, there is a lack of targeted regulations and incentives for market development. The main challenges for smart home and IoT development include lagging infrastructure and network development, stakeholder preferences and lack of support for local IT businesses. Overall, market growth is primarily fuelled by consumer demand and individual financing, necessitating strategic regulatory initiatives for comprehensive development.

Sources: [5] KEGOC, 2023. [6] Kapital.kz, 2023. [7] Ministry of Energy of the Republic of Kazakhstan. PwC analysis.

2.2.1. What changes does Kazakhstan's energy system need to undergo to facilitate the adoption of smart grid, EV charging, and smart home technologies?

Incorporating digital business models in Kazakhstan’s utility companies will be a bold step toward an energy system that is more adaptive, innovative, and consumer-friendly. However, the adoption of these DBMs will require a comprehensive transition on institutional, market and infrastructural levels across the entire energy system. In particular, the transition will require legislative changes and capacity building, the advancement of the market models which will increase the competition between utilities. These measures will stimulate investments in new technologies and infrastructure, resulting in the modernisation of the grid, incorporating advanced metering infrastructure, grid automation, and the integration of renewable energy sources ultimately enhancing the energy system's reliability and reducing dependence on imported electricity. Although these changes will result in tariff hikes, the ultimate aim is cost optimisation and lower prices for consumers. This is achievable as consumers will have the opportunity to generate income by selling energy back to the grid or by consuming during off-peak hours.

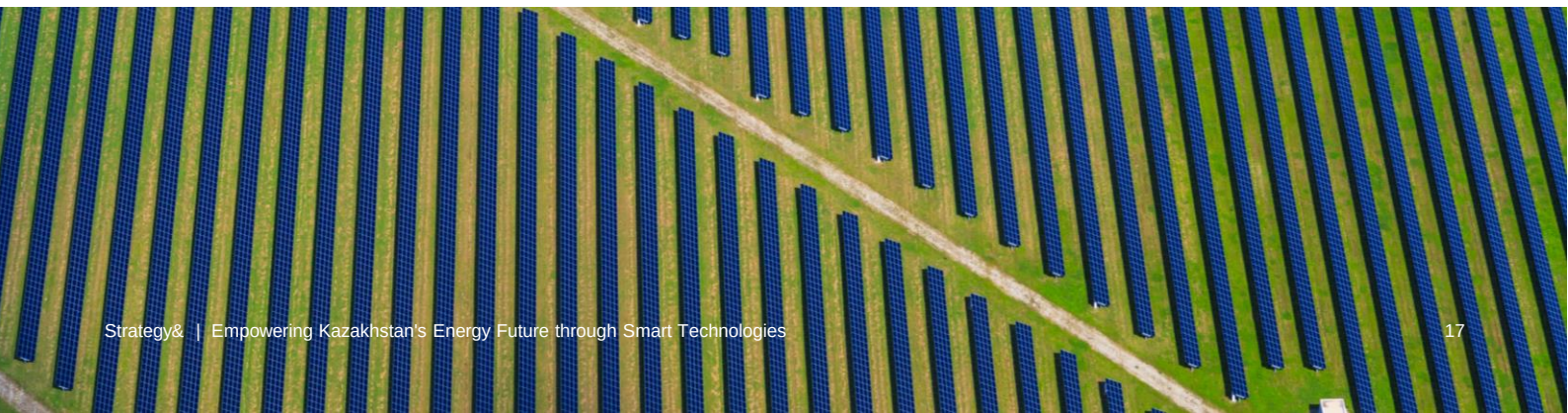
The potential benefits of these changes make it a compelling path forward for the nation’s stable energy future. Undoubtedly, the digital transformation will serve as the backbone of a modern, competitive, and efficient electric utility sector, fuelling Kazakhstan's growth for decades to come.

The new model may involve several key changes:

Unbundling	Tariff Setting	Location-Neutral Services	Regulatory Oversight
Separating generation, transmission, and distribution entities to avoid monopolies and foster a competitive environment, while also encouraging the emergence of prosumers, who both consume and produce energy, further diversifying the energy market	Transitioning from government-set tariffs to a regulatory framework that ensures tariffs reflect the actual cost of service provision and market conditions. This shift will encourage investments in infrastructure improvements, and foster sustainable energy practices	Eliminating the geographic monopoly of service provision, allowing consumers to choose their provider based on service quality and price rather than location. This shift towards a more customer-centric model could increase the quality of services available	Establishing an independent regulatory body to oversee market operations, protect consumer interests, and ensure fair competition. This body would be tasked with enforcing regulations and monitoring market practices

Digitalisation will be central to the success of this transition. A digital business model for electric utilities entails the use of digital technologies to optimise operations, improve customer engagement, and introduce new revenue streams, such as:

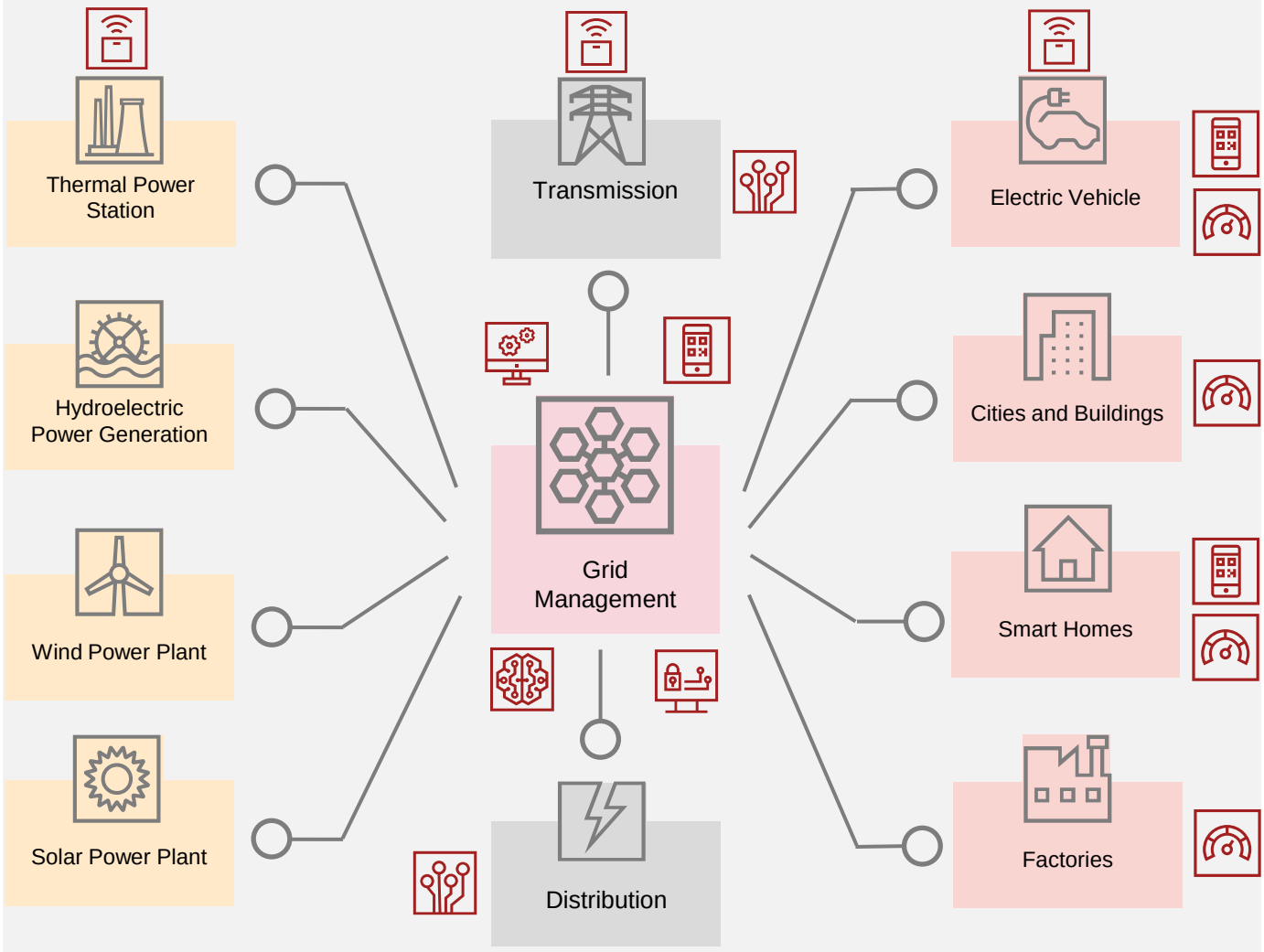
Smart metering and IoT for real-time monitoring and management.	Big data analytics for predictive maintenance and personalised services.	Blockchain for secure transactions and transparent billing.	Cloud computing for scalable IT infrastructure.



2.2.2. Modern smart grid technologies encompass a variety of different dimensional groups

This multi-dimensional approach of a Smart Grid system not only addresses current energy demands but also paves the way for future innovation and adaptability in the face of evolving energy needs and environmental challenges:

EXHIBIT 4
Smart grid technologies overview[8]



Advanced Metering Infrastructure
Gathers detailed energy usage data using smart meters

Smart Software
Optimises the performance of the grid by anticipating future needs

Cybersecurity Measures
Provides encryption, firewalls, and continuous network monitoring

Application
Empowers consumers to take control of their energy use

Grid Automation Technologies
Uses the network of sensors and IoT devices collecting data from the grid to monitor its health

Integrated Communications
Connects all elements of the grid using wireless networks and fibre optics

Power Electronics (HVDC and FACTS)
Reduces losses from electric energy transmission and distribution

Energy Management System
Harmonises energy supply and demand using demand response programmes

Sources: [8] Codibly.com, PwC analysis

2.2.3. The maturity level of the current Smart Grid model in Kazakhstan is evaluated as basic

Extensive regulation of the electricity market in Kazakhstan, accompanied by the subsidies and low tariffs[9], brought about high underinvestment in modernisation and development of the power sector and significant technical problems for both KEGOC and RECs. Resulting REC grid losses comprised 4.7 TWh of volume losses[10] (or KZT 27bn of unearned annual profit), in 2020, directly affecting both profitability and development prospects for the sector. Yet the annual energy demand is expected to continue to grow[7], with expected electricity deficit of 5.5 TWh by 2029[11] and 29% consumption growth.

Significant investments in the modernisation of the power sector are required, however, smart grid technologies can be essential to meet the expected demand growth and balance significant amounts of unstable RES generation in the country's energy transition journey. In this section, we made our assessment of the level of incorporation of smart grid technologies in Kazakhstan's electric grid to provide general understanding of our progress towards energy transition.

The Smart Grid Maturity Model (SGMM)[12] developed by Carnegie Mellon University and adopted by approximately 380 utilities worldwide[13] provides an effective framework for assessing the development stage of the smart grid infrastructure in Kazakhstan. This model offers a structured approach, enabling a comprehensive evaluation of the progress and sophistication of smart grid implementations. It encompasses a range of domains, from technological advancements to organisational structure, classifies maturity across various levels and offers comprehensive descriptions for each dimension.

While this approach offers a robust overview, it's important to note that due to the limitations of available public data, the resulting analysis might not be entirely precise. Nonetheless, even with these constraints, the SGMM can still effectively illustrate the broader picture of Kazakhstan's smart grid development, highlighting key strengths and potential areas for improvement.

In applying the SGMM, it's crucial to recognise the significant disparity in smart grid implementation between the system operator and the distribution companies. Moreover, there is a disparity in implementation among the nineteen distribution companies, and information on each entity will be required to obtain a meaningful, comprehensive picture of their current state.

Despite these constraints, there are well known recognisable challenges encountered by distribution companies on which our evaluation was based. These challenges include the lack of a unified technical policy and limited government supervision. Thus, our evaluation of Smart Grid Maturity for distribution companies was limited to the "Enabling level (level 2)".

EXHIBIT 5

SGMM matrix justification for Kazakhstan electric grid

	System Operator	Distribution Companies
Strategy, Management and Regulatory	System Operator has a clear strategic vision and is working towards integrating advanced technologies, indicating a move from basic management to more service-oriented approaches	Given the need for modernisation in the sector, it's likely that distribution companies in Kazakhstan are in the early stages of developing strategies for smart grid implementation
Organisation and Structure	Company's involvement in strategic planning, implementation of advanced technology, and emphasis on sustainable development suggest that the organisation has a structured approach towards smart grid integration	The implementation of SCADA/DMS and ASKUE technologies and digital metering efforts shows a transition towards a more sophisticated and technologically enabled operational environment. However, poor systems coverage reflects only an initial level
Grid Operations	The implementation of smart network technologies and systems like APFC for renewable integration suggests a transition from basic operational control to more advanced, service-driven operations	The implementation of SCADA/DMS and partial integration of smart metering suggests a more advanced stage in grid operations, as these systems enable better monitoring, control, and data collection
Work and Asset Management	Inclusion of modern technologies and clean energy initiatives suggests a transition towards more integrated and efficient work and asset management practices	The introduction of smart meters and IoT devices suggests an improvement in asset management, with better tracking, maintenance, and utilisation of assets

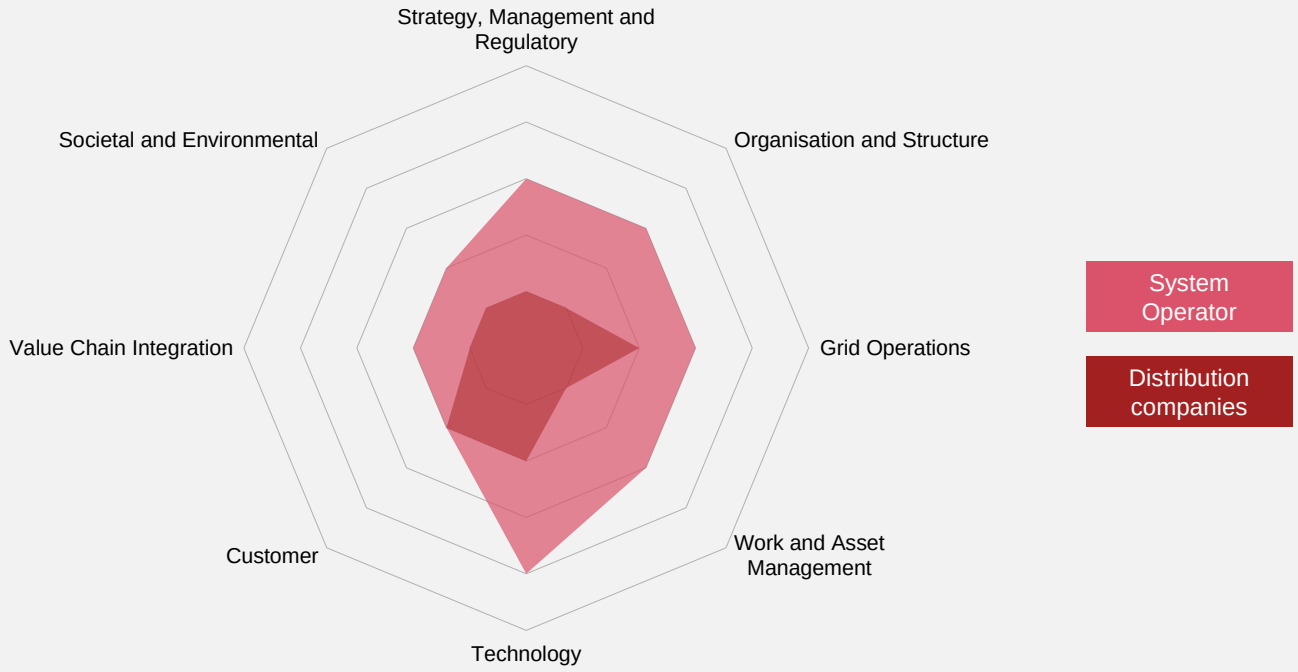
Sources: [9] PwC Kazakhstan, 2022. [10] KAZENERGY, 2023. [7] Ministry of Energy of the Republic of Kazakhstan. [11] Adilet.zan.kz, 2023. [12] Smartgrid.gov. [13] Carnegie Mellon University, 2018. PwC analysis.

Technology	System Operator's approach to the technological development is multifaceted, emphasising infrastructure modernisation, adoption of advanced technologies, digitalisation, renewable energy integration, grid security, efficiency improvements, and system integration	The use of a partially automated commercial electric power accounting system indicates a level of technological advancement beyond the initial stages
Customer	While company's primary role is in transmission and not direct consumer interaction, its operations facilitate a stable electricity market in Kazakhstan. This stability is essential for ensuring that consumers have access to reliable electricity and benefit from the efficient operation of the market. The stability is relatively maintained, but several cases of major power outages (e.g. shutdown of southern zone in 2022) still suggest an enabling level	Current level of integrated technologies suggest that distribution companies are beginning to enable more customer-focused services. Launch of smart metering campaign also offer more integrated customer engagement initiatives which suggest enabling level of this dimension
Value Chain Integration	System Operator demonstrates a multifaceted approach that encompasses efficient infrastructure management, financial robustness, commitment to sustainability, and strategic development	The adoption of smart technologies shows initiation of integrating modern solutions throughout the operations, which could lead to enhanced collaborations with technology providers and other stakeholders
Societal and Environmental	Company adopted the environmental policy aimed to reduce the environmental impact, increase the environmental safety, energy efficiency and rational use of resources	The push towards digitalisation and the use of energy-efficient technologies aligns with environmental sustainability goals, indicating a positive societal impact

Sources: Smartgrid.gov, PwC analysis

EXHIBIT 6

SGMM matrix for Kazakhstan electric grid



Source: PwC analysis

The matrix shows that the System Operator is on a solid path with its smart grid initiatives, indicating a well-established infrastructure and a good grasp of the current energy landscape. Despite this progress, there is still considerable work to be done to reach the pinnacle of smart grid evolution. For Distribution Companies, they are at an earlier phase of this journey, with many foundational elements yet to be fully developed and integrated into their operations for a seamless smart grid transition.

Sources: [12] Smartgrid.gov. PwC analysis

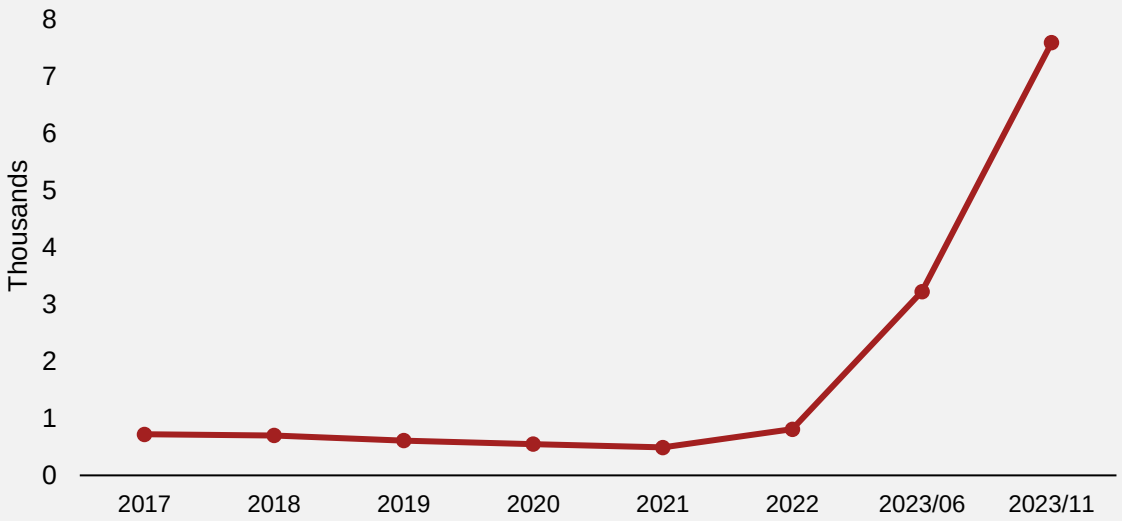
2.2.4. Current state of EV market in Kazakhstan

While Kazakhstan had seen a modest registration of EVs (passenger cars), numbering less than a thousand over the past several years, a remarkable growth has been observed over the last year (*Exhibit 7*). Bureau of National Statistics reported 3,229 EVs as of June 2023[10]. By the end of 2023[14], the Ministry of Internal Affairs reported 7,600 EVs, surpassing Ministry of Energy's previous forecast of 6,200 EVs by 2030[15]. This suggests that 2030 and 2035 forecasts will need to be adjusted. For instance, Kazautoprom (the union of automotive enterprises of Kazakhstan) now projects a range of 35,000 to 40,000 EVs by 2029[16].

Despite this recent growth, EVs still account for less than 1% of total vehicle fleet[15]. As of June 2023, from total of 3,590 electric vehicles, 3,229 were passenger cars (90%), 226 - heavy-duty vehicles (6%) and 135 - buses (4%)[15]. The majority of imported electric vehicles were from China[10]. Insights from interviews with local experts suggest that proliferation of more affordable Chinese models in the market together with tax exemptions for electric vehicles have fuelled this rapid growth. This growth trajectory is likely to continue due to decreasing battery costs from the advancements in battery technologies, leveraging more affordable components such as iron in lithium iron phosphate batteries or sodium in sodium-ion batteries[17]. Decreasing overall costs of EVs will then further amplify demand in Kazakhstan.

EXHIBIT 7

Number of registered EVs (passenger cars) in Kazakhstan, 2017-2023



Sources: Bureau of National Statistics of Kazakhstan, Ministry of Internal Affairs, Ministry of Energy

> The trend of an increasing number of EVs in Kazakhstan is inevitable. Affordable cost and futuristic designs of EVs, along with financial and non-financial benefits such as tax exemptions and special access to protected natural areas like Shymbulak in Almaty, have grabbed the attention of local drivers to consider purchasing an EV. We anticipate a significant initial surge, though growth may slow down due to limited number of EV charging stations."
>
> **Beknur Nessipbayev,**
> **CEO of Astana Motors**

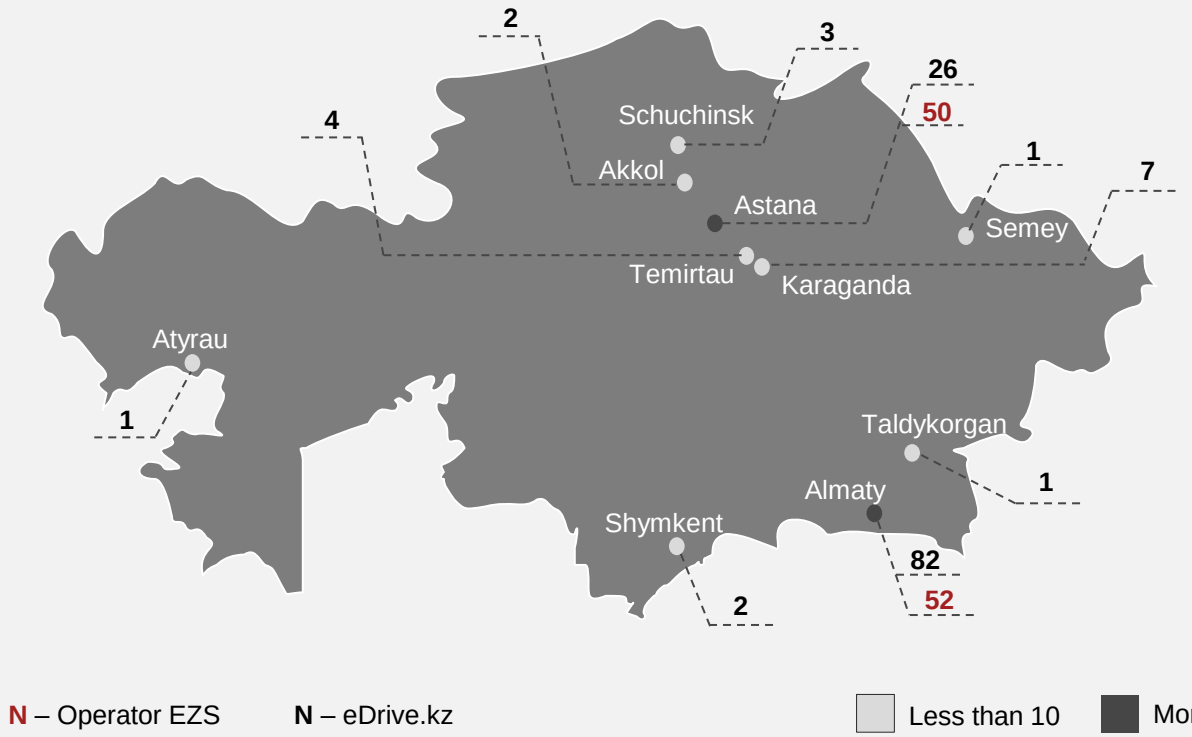
Despite the government's financial incentives and the availability of a diverse range of EVs, one significant hurdle to their adoption in Kazakhstan is the scarcity of charging infrastructure. The development of this infrastructure is significantly impeded by the absence of standards and regulations. It is currently estimated that there are 203 charging stations in Kazakhstan[10], which makes ratio of EVs to stations – 37:1, making it notably higher than the global average ratio of around 10:1[17]. For comparison, the lowest available ratio globally is of 2:1 in South Korea[17].

Sources: [10] KAZENERGY, 2023. [14] Tengrinews.kz, 2023. [15] AIFC, 2023. [16] Informburo.kz, 2023. [17] IEA, 2023.

2.2.5. Current development of EV charging infrastructure in Kazakhstan

Kazakhstan's EV charging network is limited in its development, primarily concentrated in the two major cities of Astana and Almaty. Some other cities accommodate a handful of stations, yet there is no rapid charging infrastructure along intercity highways[18,19] (*Exhibit 8*). Despite the early stage of the EV market development in Kazakhstan, there is potential for it to align with the global movement toward electric vehicles and provide investment opportunities for companies and startups exploring e-mobility. However, the absence of standards and a strategic vision for e-mobility development might affect its potential. Companies to first approach the EV infrastructure are of different calibre – some companies focus on importing charging stations and offer charges of different scale, capacities and quality, while others prioritise production of the proprietary charging stations. There is also a growing interest from the automotive industry, due to the direct impact on their core business.

EXHIBIT 8
Distribution of EV charging stations across Kazakhstan



Sources: eDrive.kz, Operator EZS

eDrive.kz calls itself a System integrator of the charging infrastructure of EVs in Kazakhstan offering charging stations of various capacities, from 3 kW to 180 kW AC and DC, supplying both famous world brands and budget models manufactured in China. eDrive.kz claims to have a proprietary software with an advanced functionality. Users can select desired stations, check availability, plot a convenient route, charge, control, pay, monitor the charge and the car[18].

Adele Energy, on the other hand, has a full fledge production, i.e. designing, testing and manufacturing its own charging station control board (controller) with corresponding patents for its developments. According to the executives, Adele Energy was evaluated as top 4 best infrastructure solutions for charging electric vehicles across Europe. The company provides two types of charging stations – Nova (AC) and Foton (DC) stations, which presumably support all charging protocols and can charge any type of EV.[20]

Operator EZS was established by Zhasyl Damu JSC, a government-owned company, as part of a pilot project on the development of EV production and charging infrastructure[19]. Recently, Zhasyl Damu held negotiations with Turkish investors, "White Rose" company, on the development of charging infrastructure. Other than that, limited information is available about company's activities.

Sources: [18] Edrive.kz. [19] Operator EZS. [20] Adele Energy.

Furthermore, official EV distributors, such as Orbis Auto (ZEEKR) and Astana Motors (BYD), might take an auxiliary role to charging infrastructure development. Orbis Auto automobile group has been granted official rights to sell and service premium smart electric vehicles under the ZEEKR brand in Kazakhstan[21]. The company prioritises providing repair and maintenance services for their existing clients, recognising this as a crucial barrier hindering drivers from transitioning to EVs. Leveraging their official dealership network allows them a comprehensive access to services and spare parts.

Orbis Auto expects the number of charging stations to organically increase as the market demand rises. Acknowledging the distinct differences between the automobile business and EV charging infrastructure, the company does not intend to directly engage in building charging stations unless shortage becomes critical. In such cases, establishing a limited number of stations can be considered to support the customer base.

> As the number of EVs continues to surge, increasing demand for charging infrastructure is expected to organically drive its expansion in the market. While our company does not have immediate plans to construct EV charging stations, we intend to do so in case natural growth proves insufficient, aiming to support our valued customers."
>
> **Farrukh Makhmudov,**
> **Chairman of the Board of Directors of Orbis Kazakhstan**

In comparison, Astana Motors has already committed to building EV charging infrastructure in 2024. Through a partnership with a Chinese company TELD New Energy Co., Ltd., Astana Motors aims to access cutting-edge equipment, expertise and elaborate safety standards. Initially focusing on three key cities — Astana, Almaty, and Shymkent — Astana Motors aims to establish an electric charging network alongside its cars manufacturing and sales business functions. Depending on the charging network's success and subject to financial feasibility, the company might potentially consider manufacturing of the charging stations too.

> The EV charging infrastructure market is set to welcome various participants, including petrol station operators, companies exploring new areas for growth, and car manufacturers and sellers. Given the current ratio of EVs to charging stations, there's a substantial demand for more charging stations. This suggests that the market will likely accommodate most, if not all, potential players."
>
> **Beknur Nessipbayev,**
> **CEO of Astana Motors**

Current governmental initiatives

To encourage the uptake of electric vehicles, the government has implemented exemptions from customs duties, transport taxes, and recycling fees. These exemptions make EVs more financially appealing compared to internal combustion engine (ICE) vehicles[15]. Furthermore, this year, the government has ratified a "Roadmap" aimed at establishing the essential infrastructure for electric vehicles in all major cities by 2029[22]. This plan involves financial incentives such as exempting EVs from toll road charges (effective from 2024), waiving the initial state registration fee, exempting electric buses from transport taxes, and offering leasing options for individuals purchasing EVs.

The roadmap also encompasses non-financial and infrastructural initiatives. It intends to allocate separate lanes for EVs starting in 2024 and introduce tax deductions for installing EV charging stations for both legal entities and individuals. The government also plans to explore the production of local electric charging stations. Additionally, local authorities in each city will be responsible for determining the locations and specifications of future charging stations. Several of these initiatives may face challenges or prove suboptimal, as detailed further on page 32.

Sources: [21] Forbes.kz, 2023. [15] AIFC, 2023. [22] CCS under the President of the Republic of Kazakhstan, 2023.

The state has also been active in legislative work and has amended several pieces of legislation to include and promote the adoption of EVs[23]. The definition of EVs has been incorporated into relevant existing laws. Another example is consideration of special electric vehicle parking lots with charging stations at the planning stage in all city zones, with no ICE cars allowed in such parking lots. There is also a clause on prioritising EVs in road regulation and allowing separate lanes for extra mobility.

Furthermore, there is a clear emphasis within governmental structures on valuing and prioritising safety. There are concerns from the Ministry of Emergency Situations regarding fire safety of charging stations, namely the location of charging stations, the number of electric vehicles and charging stations to be accommodated, and the allowable distance[24]. The ministry is consulting with the governments of China and Turkey to create regulatory documents, but until their enactment, car charging is banned in almost all indoor and outdoor parking lots.

Private sector initiatives

As the global shift towards electric vehicles has unfolded over the past decade, the private sector has expressed keen interest in this emerging market, recognising the need and playing an active role with regards to regulatory changes and financial initiatives and opportunities.

The newly formed Kazakhstan Automobile Union, established this year to foster the growth of the country's automotive industry, is actively drafting proposals aimed at developing the regulatory framework for the establishment of charging infrastructure across Kazakhstan. These proposals are being prepared for submission to the government for thoughtful consideration[25].

Financial institutions are also adapting to this trend by introducing new products and participating in programmes aimed at incentivising the purchase of electric vehicles by individual consumers. Halyk Bank, for instance, plans to launch green loans specifically designed for EV purchases, featuring lower interest rates compared to regular loans[15]. Additionally, there is a collaboration between EBRD and Bank Center Credit to finance green technologies, enabling both individuals and businesses to receive cashback compensation equivalent to about 10-15% of the loan amount[26,27].

Businesses also have the option of issuing green bonds on either the Kazakhstan Stock Exchange (KASE) or the Astana International Exchange (AIX). For instance, KEGOC recently issued green bonds, attracting investments from the Development Bank of Kazakhstan and EBRD[28]. Additionally, these bonds could potentially benefit from subsidies offered by the DAMU fund, which focuses on financing SMEs in priority economic sectors or green initiatives[29]. An illustration of this is Freedom Finance’s placement of green bonds of Black Biotechnology LLP, where the coupon interest rate is primarily subsidised by the DAMU fund[30]. Leveraging these instruments provides opportunities for businesses seeking funds to invest in EVs or EV charging infrastructure.

Despite the promising prospects of a growing EV market, businesses still remain cautious. Unlike in other countries in the region (e.g. Uzbekistan) where EVs are more cost-effective due to higher petrol prices and lower electricity costs, Kazakhstan boasts relatively affordable and inexpensive petrol prices. Consequently, the financial incentives for adopting EVs become less compelling. Moreover, challenges persist, including the comparatively higher price of EVs compared to ICE vehicles and the lack of charging infrastructure, both of which impede people from transitioning to electric vehicles. However, despite these challenges, as technology advances and environmental consciousness grows, the movement towards EVs is poised to continue its upward trajectory in Kazakhstan, akin to developments observed worldwide.

> “Transition to EV has already happened. The moment when EU and US set policies on banning the ICE vehicles, when other countries set the targets regarding EVs, it was evident that we will eventually shift to this direction. We expect that Kazakhstan cars will all be electric within 20 years.”
>
> **Ivan Trofimov**
> **Business Development Director of Adele Energy, manufacturer of EV charging infrastructure**

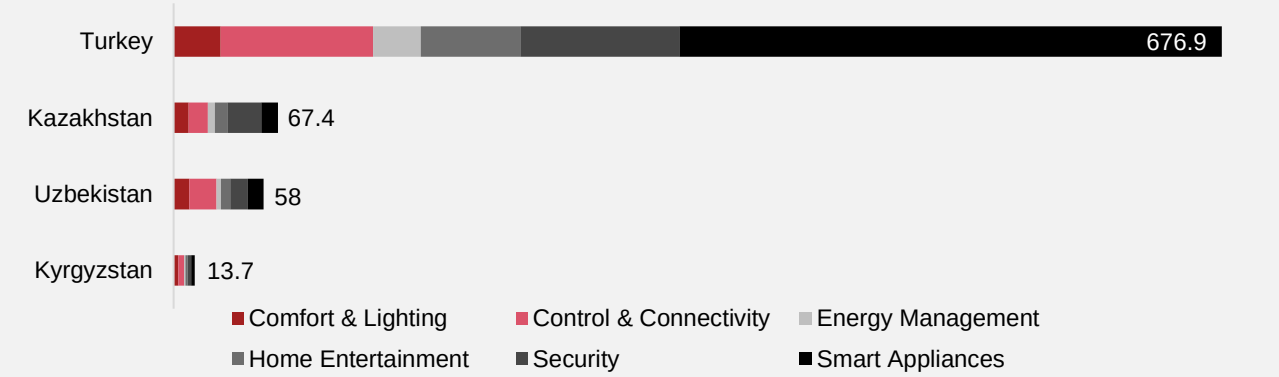
Sources: [23] Mazhilis of the Parliament of the Republic of Kazakhstan, 2023. [24] Informburo.kz, 2023.[15] AIFC, 2023. [25] Astana Motors, 2023. [26] Bank Center Credit. [27] Bank Center Credit, 2023. [28] KASE, 2023. [29] Kursiv.kz, 2023. [30] KASE, 2023.

2.2.6. Smart home technology market in Kazakhstan is expected to grow

Current market for smart home technologies in Kazakhstan is quite sizable with a tangible demand. There are several providers that offer a range of smart home and IoT technologies, including security (access control, fire detection), comfort and lighting (occupancy sensors, climate and air quality control), smart appliances (smart outlets, taps, etc.), control and connectivity (sensors and controls), energy management and home entertainment.

EXHIBIT 9

Comparison of revenue for smart home technologies across countries estimated for 2023, million USD



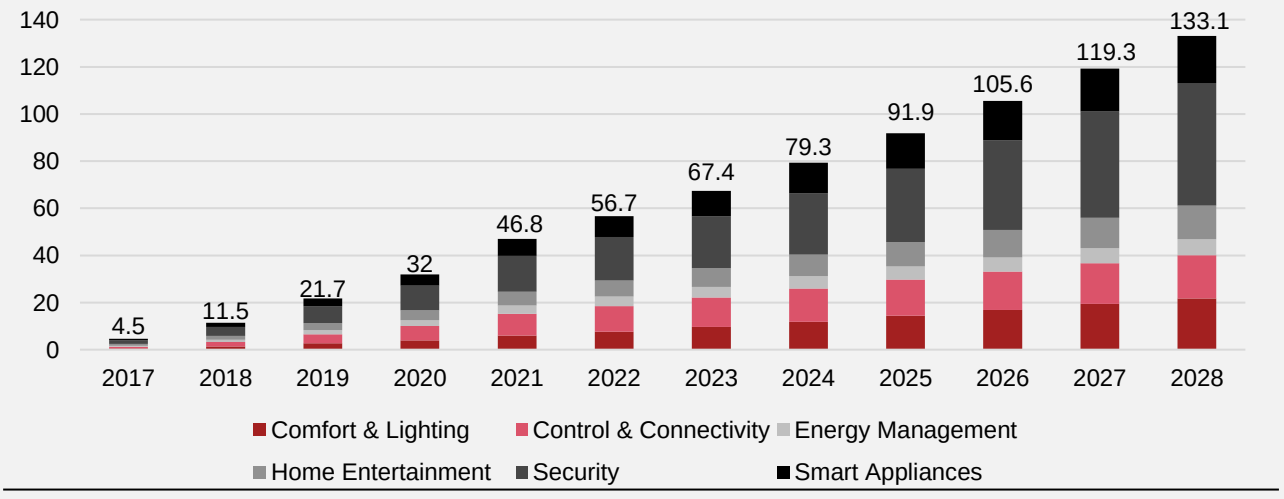
Source: Statista Market Insights

When compared to other countries in the Central Asian region, Kazakhstan represents one of the highest levels of smart home technology implementation based on the revenues. However, compared to more mature markets, like Turkey, significant potential for further market growth can be observed. On the basis of smart home revenue per capita, this difference is lower but still significant, amounting to double that of Kazakhstan. Moreover, contrary to Kazakhstan, Control & Connectivity and Smart Appliances constitute the primary components of the revenue mix in other countries.[31-34]

Approximately 5.2 million households exist in Kazakhstan, representing a potential market for smart home technologies that could involve around 70 million sensors[2]. There is no available statistical data on smart home integration except for general market projections. The current revenue for smart home technologies in Kazakhstan is estimated at USD 67.4 million, with 284.5k active users[31]. The smart home market in Kazakhstan is forecasted to experience substantial growth, with projections reaching USD 133.1 million by 2028, an anticipated annual growth rate of 14.59%[31]. Correspondingly, the number of active households in the market is expected to rise, reaching an estimated 629.6k users by 2028[31].

EXHIBIT 10

Revenue forecast for smart home technologies in Kazakhstan, million USD



Source: Statista Market Insights

Sources: [31,32,33,34] Statista, 2023. [2] Satuyeva et al., 2019.

As the market grows, the adoption of smart home technology by households is poised to rise. The anticipated household penetration rate was projected to reach 4.7% in 2023, with expected increase to 9.4% by 2028[31]. Thus, an upward trajectory in revenue, household penetration and number of active households indicate substantial growth potential of the smart home market in Kazakhstan.

284.5k
estimated active users

4.7%
projected household penetration rate

> Similar to the smartphone market - smart home and IoT technologies are becoming the new necessity. These are technologies that did not exist in the mass-market just 5 years ago. The technology in the market is improving, becoming more accessible every year, and therefore, the needs and preferences of the market are adapting. People's lifestyles are also changing. Many now split their time between two cities, often leaving their homes empty for long periods."
>
> **Mukhtar Kuanyshbaiuly,**
> **CEO of Connected Home, smart home and IoT expert**

As a part of smart home tech, the energy management market in Kazakhstan is anticipated to experience a significant growth in revenue, reaching USD 6.8 million or attracting 220.4k users by the year 2028[35]. Energy management is important to the smart home's interaction with the energy system, however, smart home market in Kazakhstan is mainly characterised by strong preference for enhanced convenience and security in automated building systems.

> In addition, there is an urgent need to introduce IoT and smart meters for utility data, as almost all cities in Kazakhstan use pulsed analogue technologies to record energy consumption data. The exception is the capital, where wireless LoraWAN meters are being introduced. Integration of meters with the smart home system will provide residents with information about electricity and water consumption in tenge, thus motivating people to save energy. An additional bonus from the introduction of smart meters will be an ability to monitor and control illegal practices, such as black and gray mining of cryptocurrencies."
>
> **Mukhtar Kuanyshbaiuly,**
> **CEO of Connected Home, smart home and IoT expert**

Current smart home regulation

As of March 2023, there is an adopted standard for NarrowBand IoT (NB-IoT) in Kazakhstan. Devices connected to the NB-IoT network have high communication stability, achieving 100% data transmission from controlled objects due to the licensed frequency range[36]. NB-IoT technology boasts significant network capacity, coverage in hard-to-reach locations, as well as maximum autonomy and energy efficiency of the devices.

Existence of the universally accepted standard for IoT devices and platforms addresses the issue of interoperability and compatibility of devices. The standard will also contribute to market growth, increase in quality, accelerated digitalisation and will bring the country into the global NB-IoT industry.

Other than that, there is no targeted regulation or governmental incentives for smart home and IoT to promote development and expansion of the market, as well as any regulation addressing data security and privacy. Smart home market growth is mainly driven by consumer demand and financed by the end users.

Sources: [31] Statista, 2023. [35] Statista, 2023. [36] Profit.kz, 2023.

Financing mechanisms for smart home technologies

There are smart home financing mechanisms available for individual customers and small businesses that can help promote sustainable and energy-efficient practices.

Smart home entrepreneurs can qualify for regional development initiatives from the DAMU fund, which provides financial assistance and incentives for small businesses in major cities and regions of Kazakhstan. The fund offers an opportunity to subsidise loans for investment or working capital obtained from commercial banks, reducing the interest rate from 21.75% to 7-8%.[37]

Otbasy Bank's innovative green mortgages, which require a green building certification, encourage customers to invest in smart technologies, raise energy efficiency of the buildings and pursue personal environmental goals. The green mortgage offers a competitive interest rate of 12.5% with further potential reductions and a larger limit on the price of housing compared to other offers.[38]

Home Energy Management System (HEMS) Prototype in Kazakhstan[39]

The research conducted by Astana IT University indicate that Home Energy Management Systems (HEMS) have the potential to address the issue of unconscious electricity consumption in residential buildings. The developed prototype, based on hardware IoT, enables users to monitor their real-time consumption profiles, leading to a reduction in electricity costs. The HEMS microcontroller transmits data from energy meters and occupancy sensors to a remote server through an API. The suggested system issues push notifications via a mobile app in cases of excessive consumption or when users forget to turn off appliances before leaving their homes. Furthermore, the system can be utilised for differentiated electricity tariffs to participate in demand response initiatives during peak and off-peak hours.
The estimated cost of the prototype system is USD 330, which is not very attractive for the prototype due to the small scale – there are only 28 systems in the batch.

For users consuming 300 kWh per month, the anticipated monetary savings are approximately KZT 7,000 per year with a 10% reduction in electricity consumption. In a differentiated tariff zone, savings are projected to be KZT 8,000 by shifting 50 kWh to night-time usage, with an additional KZT 4,000 for a 10% reduction in electricity consumption.

Sources: [37] Bank Center Credit. [38] Otbasy Bank. [39] Zhakiyev et al., 2023.

2.3. So what are the challenges to implement these technologies and respective recommendations?

In Kazakhstan, closing the implementation gap would comprise two primary stages. Firstly, smart technologies, including smart grid, EV charging, and smart home would have to be fully incorporated into the country's energy systems before fullscale digitalisation can take place. Challenges and implementations identified below would have to be addressed. Only after that Digital Business Models for utilities can be implemented as described by Strategy& (detailed on pages 41-45).

2.3.1. Smart grid implementation challenges

Kazakhstan faces several systemic challenges in the implementation of smart grid technologies, reflecting a broader struggle with innovation and lack of investments in the energy sector. While the potential for enhanced efficiency and reliability is significant, the transition to a smart grid infrastructure is hindered by a lack of clear legislative frameworks, undefined standards for new technologies, insufficient investments, and minimal stakeholder engagement. These obstacles collectively undermine the country's efforts to modernise its electrical grid and adopt sustainable energy practices.

1. Regulations for smart grid are not well-established

The implementation of smart grid technologies requires a **legislative environment** that both supports innovation and regulates deployment. In Kazakhstan, the legislative landscape lacks the specificity and guidance necessary for the rollout of smart grids. Without clear policies, utility companies and investors are uncertain about compliance, long-term expectations, and the return on investment for smart grid technologies.

The **lack of standardised protocols** and benchmarks for smart grid technology in Kazakhstan has resulted in a fragmented approach to adoption. This absence of standards hinders interoperability, scalability, and security, which are essential for the successful integration of various smart grid components and systems.

The deployment of smart grid technologies in Kazakhstan not only requires **the establishment of clear, measurable target indicators** but also necessitates a framework for **transparent monitoring** and rigorous oversight of fund allocation and the progress toward these set goals. This should be complemented by regular reporting mechanisms that allow for adjustments and accountability, ensuring that every step towards the implementation is aligned with the country's strategic energy objectives and contributes to the sustainable development of the power sector.

2. Lack of investment for smart grid development

Investment is critical to developing the infrastructure necessary for smart grids. However, the energy sector in Kazakhstan currently experiences a shortfall in both public and private funding. This financial gap is a significant barrier to the acquisition and implementation of advanced technologies required for a smart grid transition.

3. Limited stakeholder engagement

Successful smart grid implementations are typically characterised by active participation and collaboration among a wide range of stakeholders, including government bodies, technology providers, utility companies and consumers. In Kazakhstan, there is a notable lack of involvement from these groups, leading to a disconnection between potential benefits of smart grid technologies and those who stand to benefit from them. The limited interaction results in a lack of consensus and coordinated effort toward common goals in the smart grid arena.

2.3.2. Recommendations for the development of smart grid technologies

Germany has an energy model with successfully implemented smart grid technologies. Kazakhstan can look to Germany’s Energiewende as a model for driving its own transition to a more sustainable and efficient energy system. By adopting key elements of Germany's approach, such as a strong regulatory framework, investment in innovation, and stakeholder engagement, Kazakhstan can make substantial progress in modernising its grid, managing renewable integration, and setting a benchmark for energy reform in the region.

Germany's Energiewende: Implications for Smart Grid Deployment[40]

Transition in energy system happened in Germany with adoption of Energy Industry Act of 1998, which dismantled the existing monopolies and introduced measures to foster competition and efficiency. The market liberalisation required the separation of energy generation, transmission, and distribution operations. This 'unbundling' was a crucial step in eliminating conflicts of interest and facilitating fair competition, allowing new, innovative players to enter the market. The Federal Network Agency ensured equitable access to the grid and supervised a transparent tariff system. Its role was pivotal in steering the market toward fair competition and consumer protection.

The newly competitive landscape encouraged energy suppliers to differentiate themselves by offering not just competitive pricing but also innovative services. Smart meters began replacing old electricity meters, allowing consumers and utilities to monitor energy use in real-time, enabling dynamic pricing models and promoting energy savings. A key driver for smart grid development has been the integration of renewable energy sources. Germany's aggressive push for renewables required a grid capable of handling intermittent energy flows, necessitating advancements in energy storage and distribution management.

Liberalisation did not instantly solve all issues; prices fluctuated, and market power remained concentrated. Yet, the liberalised framework fostered a favourable environment for smart technology investment, with smart grids emerging as the backbone of Germany’s renewable energy revolution. Germany’s shift to a liberalised electricity market catalysed a pivotal transition to smart grid technologies. This transition was a redefinition of the energy landscape, promising a future of sustainable, consumer-driven, and intelligent energy management.

Sources: [40] Agora Energiewende.

The essential steps for fostering liberalisation of the energy sector in Kazakhstan

Policy and Regulatory Framework

Kazakhstan needs to establish clear policies and a regulatory framework that encourage the adoption of smart grid technologies. This would include financial incentives for renewable energy use and the modernisation of grid infrastructure.

Smart grid technology is capital intensive. It is important to offer transparent investment mechanisms and clear market incentives for domestic and international investors that will entail reasonable returns and payback periods.

Investment in Technology & Infrastructure

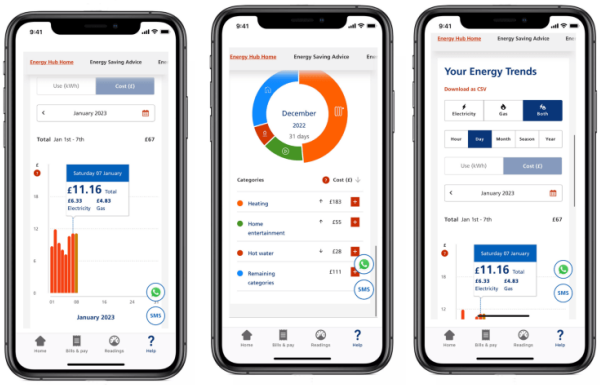
Stakeholder Engagement

It is essential for Kazakhstan to involve all stakeholders in the energy transition process, including energy providers, consumers, and the government. This will ensure a smoother implementation and greater acceptance of new technologies.

Kazakhstan should invest in research and development to foster innovation in smart grid technologies, tailored to its unique geographic and economic context.

Research and Innovation

EXHIBIT 11
Energy Hub app interface by EDF Energy (UK)



Source: EDF Energy

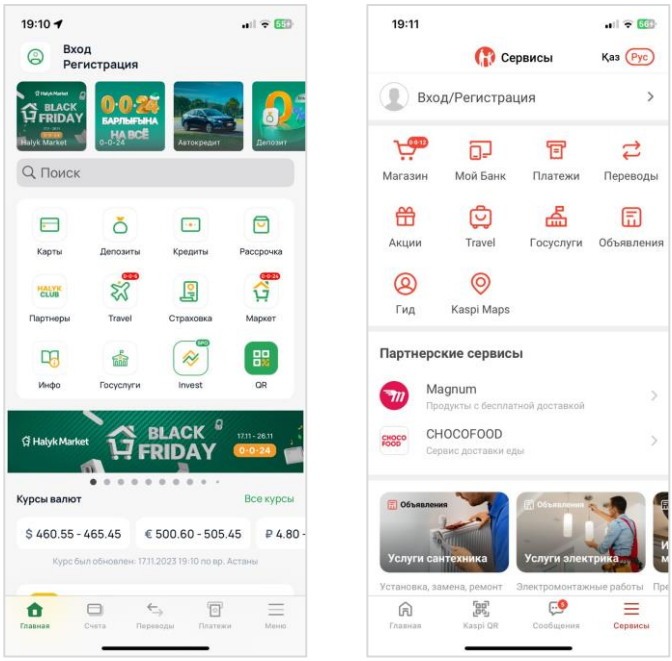
While addressing institutional and market challenges sets the foundation, an actual implementation of digital solutions, such as proprietary apps, is viewed as an active change towards putting it into practice.

Such applications illustrate successful implementation of smart grid technologies. They include a highly intuitive app that allows for real-time monitoring of energy usage, provides tailored suggestions for reducing energy consumption, and integrates smoothly with smart home devices. Such an approach could significantly aid Kazakhstan in enhancing energy efficiency, consumer engagement, and the overall sustainability of its energy infrastructure.

Leveraging existing Digital Ecosystems in Kazakhstan

Kazakhstan already has great examples of integrating digital business models and providing enhanced customer engagement. The level of digitalisation in Kazakhstan's financial services sector is among the most advanced in the world. The super apps of KASPI and Halyk could provide great leverage and effectiveness when incorporating features of the Energy Hub to their digital platforms. Among other digital finance products and services, these apps are already working with electric utilities and generate electric bills. Integrating additional functionalities to offer a seamless and efficient way for consumers to manage their energy consumption could help streamline the transition to smart grid technologies. This approach would then help capitalise on the digital savvy of the Kazakhstani population and ensure a smoother adoption of advanced energy management solutions.

EXHIBIT 12
Halyk and KASPI super apps interfaces



Source: Halyk Bank, KASPI Bank

2.3.3. EV charging infrastructure challenges

1. Lack of regulation on EV charging infrastructure

The development of EV charging infrastructure is hindered by the absence of government-defined standards and regulations. The recently approved roadmap lacks specific targets and a unified approach applicable across all regions. Responsibility for determining station locations and power capacities falls to local authorities, potentially lacking the necessary expertise and KPIs for deployment of the infrastructure. It remains unclear which standards and metrics they will follow and how they will coordinate with each other.

Furthermore, one of the aspects the roadmap focuses on promoting local manufacturing of charging stations. Similar to other roadmap initiatives, it lacks detailed implementation plans, raising concerns about the state entering and monopolising the market and impeding natural market growth, even despite an increasing interest from the private sector. Secondly, with both established manufacturing companies and upcoming market participants driven to accommodate the demand, this initiative might prove inefficient and divert resources from supporting existing or upcoming companies already equipped with end products or resources. Lastly, monopolisation of the market by the state might result in its stagnation due to limited resources and motivation, as evidenced by the example of Operator EZS.

Moreover, the roadmap currently lacks comprehensive safety regulations on the installation of charging stations. Although based on the insights from our interviews with experts, the private sector is currently engaged in collaborative efforts with the government to formulate these safety regulations, there is no publicly available information on any progress.

The recently approved roadmap lacks specific targets and a unified approach

2. Lack of governmental incentives

The second challenge is the absence of government support that could facilitate expansion of the EV charging infrastructure. Despite the urgency to match the global transition to EVs, recent regulations and the EV charging infrastructure roadmap do not outline any strategies for subsidising the implementation of EV charging infrastructure in Kazakhstan. In addition, there is still an ongoing subsidising of the ICE market, with numerous funding provided to well-established companies.

Even with the active natural market growth, government subsidies might provide crucial support. Since installation of EV charging stations is capital intensive, many businesses still hesitate to enter the market despite promising opportunities. Thus, government backing could facilitate charging network deployment, which would further support the appeal of EVs. In addition, government support would be critical for the provision of fast charging stations along highways due to substantial capital requirements of fast chargers.

2.3.4. Recommendations for effective development of EV charging infrastructure

1. Developing a comprehensive strategy for EV charging infrastructure development

Firstly, it's recommended to develop a comprehensive strategy for transitioning to electric vehicles that encompasses various initiatives and territories and establishes precise objectives across all aspects of EV integration. For instance, the Australian government recently introduced the National Electric Vehicle Strategy. This document ensures a consistent nationwide approach, aligning standards and procedures between the central government and state and territorial governments.

National Electric Vehicle Strategy of Australia[42]

The strategy has three main objectives that address supply, systems and infrastructure, and demand aspects of EV adoption. The document structures all existing and new targets and initiatives in the country. Fuel Efficiency Standard, for instance, is developed to increase supply of affordable and accessible EVs; National Electric Vehicle Charging Network would help establish the resources, systems and infrastructure to enable rapid EV uptake, and Electric Car Discount encourages increase in EV demand.

The Australian governments collaborate with each other to deliver EV charging stations standards, cybersecurity and smart functionality, which would be aligned between territories and internationally, where possible. Other priority areas include developing a common mechanism for charging stations data sharing, nationally aligning Service and Installation Rules, and streamlining procedures for connecting consumer energy resources, including EV charging stations, to the network.

Furthermore, alongside the development of regulations governing the installation and operations of EV charging infrastructure, new buildings should be designed to accommodate the integration of charging stations. This approach was practiced in China, the largest EV market globally, and it is also included in the National Electric Vehicle Strategy of Australia.

EV charging stations as part of the urban infrastructure[42,43]

In 2016 China introduced the policy to incorporate EV charging stations as crucial elements of urban planning, establishing a network primarily centred around residential areas with additional support from public charging facilities in communal parking spaces. It also ensures that all newly constructed residential parking spaces either include charging infrastructure or allocate space for future installation. Policy includes the targets such as 1) public parking lots should have charging facilities available for a minimum of 10% of their spaces, and 2) to have at least one fast charging station for every 2,000 EVs.

Similar practice is proposed in the 2022 update of National Construction Code of Australia, which ensures that new buildings are planned, built, and equipped to facilitate the integration of renewable energy technologies and EV charging stations. Moreover, the government will conduct research to inform and enable the adoption of EVs among residents of multi-residential buildings.

Sources: [42] DCCEEW, 2023. [43] Australian National University, 2023.

2. Allocation of governmental subsidies to EV charging infrastructure

Another significant aspect to consider is government funding and subsidies aimed at building the charging network. The primary driver behind the success of the EV market in China is the extensive support and dedicated focus of the government on the industry's growth.

Case of China – the major player in EV industry

From the beginning of its journey, China heavily subsidised R&D and technical innovation, provided customers financial incentives, meanwhile expanding the charging network through the set of national strategies. As the industry was steadily developing, the government was gradually reducing its incentives, transforming the industry from policy-oriented to market-oriented[43].

To enable EVs transitioning, the government should reconsider its current subsidies and prioritise the charging infrastructure as the core driver of the demand growth for EVs. Financial incentives for ICE vehicles are received by well established market leaders that might function well without governmental support. Moreover, subsidising the ICE market could potentially be loss-making, as its market share has peaked in 2017 and is continuously declining since then, according to RMI analysis[44].

> ICE vehicles are becoming less attractive globally, and if we do not properly manage the EV transition, our country is risking to become the dump yard for conventional vehicles, since people would be attracted to low cost of ICE cars."
>
> **Ivan Trofimov,**
> **Business Development Director of Adele Energy, manufacturer of EV charging infrastructure**

Sources: [43] Australian National University, 2023. [44] RMI.org, 2023.

Sources: [n+2] X-change: Cars, [n+1] China's EV plans; [n+3] – Adele Energy

2.3.5. Smart home implementation challenges

1. Lack of enabling environment and infrastructure

The effective implementation of IoT hinges on a robust and sophisticated infrastructure, including high-speed internet connectivity. In regions grappling with inadequate infrastructure, introduction and expansion of IoT solutions pose considerable challenge. Consequently, it becomes imperative to invest in the development of Kazakhstan's national network, extending coverage to rural and disconnected areas. The primary network challenge stems from the substantial cost of connectivity, a consequence of Kazakhstan's vast territory. Presently, the network's evolution allows solely for the adoption of the LoraWAN standard for IoT integration, which, in comparison with more contemporary NarrowBand IoT technologies (NB-IoT), appears somewhat dated. A similar example is found in Uzbekistan, where the widespread use of GSM has fuelled a notable upswing in the deployment of IoT devices and sensors. Therefore, it is critical to propel and **incentivise network development** through regulatory measures.[45]

Insufficient network coverage poses the main challenge for the development of IoT industry.

2. Stakeholder preferences

The integration of IoT technologies brings about a transformative impact by enhancing the accuracy and transparency of consumption data. While these advancements promise numerous benefits for efficiency and resource management, certain stakeholders express resistance to such transparency. Stakeholders, particularly those with vested interests in maintaining opaque practices, **may resist the implementation of IoT** solutions due to fears that the increased transparency could expose inefficiencies, malpractices, or even instances of corruption within their operations. This opposition can impede the widespread adoption of IoT, limit generation of valuable data, and hinder the outreach of these technologies.[45]

3. Insufficient support of local tech

According to Kazakhstani providers of IoT solutions, a general trend is noticeable where **foreign solutions are given preference** over their local counterparts in the market and within governmental procurement processes. This inclination is often evident despite the presence of competitive and cost-effective offerings from Kazakhstani entrepreneurs. This prevailing bias poses a significant challenge for domestic businesses, hindering their growth and stifling the potential for innovation and economic development. The reluctance to support local manufacturers can be attributed to a lack of trust, even in the face of experienced software and hardware specialists capable of delivering competitive solutions, and ingrained perceptions regarding the reliability, quality, or capabilities of local products and services. The tendency to favour foreign solutions may also be influenced by a belief that international brands inherently offer superior technologies.[45]

Sources: [45] Kuanyshbaiuly, 2023.

2.3.6. Recommendations to promote smart home and IoT integration

1. Incentivise development through regulation

In order to provide enabling environment for the growth of smart home and IoT technologies, it is important to prioritise the accelerated expansion of internet coverage across all regions of Kazakhstan. The President emphasised addressing issues related to high-speed internet access in rural areas this October[46]. Ministry of Digitalisation has an opportunity not only to benefit the population but also serve as a vital catalyst for the faster development of IoT technologies. An increased internet coverage will also act as a necessary stimulus for the successful implementation of NB-IoT, contributing to the fulfilment of strategic objectives such as deploying 5G networks in all regional centres by the end of 2025[47].

As the next step, it is suggested to formulate and implement a comprehensive national strategy for IoT development, encompassing infrastructure, regulations, and incentives to encourage telecommunication companies to invest in expanding their networks to rural areas. This could include tax incentives, subsidies, or reduced regulatory barriers to make rural expansion financially viable and attractive for these companies.
The strategy should outline clear goals, timelines, and performance metrics, fostering a coordinated and strategic approach to IoT implementation.

2. Prioritise transparency

To address the challenge of stakeholder opposition, it becomes crucial to not only emphasise the operational advantages and efficiency gains brought about by IoT but also to establish robust regulatory frameworks that safeguard against misuse of the generated data. Collaborative efforts involving government bodies, businesses, and civil society can play a pivotal role in building trust and fostering an environment where stakeholders see the benefits of transparency outweighing the risks. Building trust, promoting transparency, and establishing regulatory safeguards are essential to overcome obstacles to the widespread adoption of IoT.

3. Promoting local innovation

Addressing the preference for foreign tech necessitates increased awareness and recognition of the capabilities of Kazakhstani entrepreneurs. Highlighting success stories and showcasing local solutions' effectiveness can dispel misconceptions and build confidence among procurement specialists. Additionally, it might be helpful to implement measures to level the playing field, such as promoting fair competition and providing incentives for local technology adoption. Bridging the gap requires concerted efforts from various stakeholders, including government bodies, businesses, and the broader community. It is important to nurture an environment that values homegrown innovation.

4. Alternative financing mechanisms

As a long-term initiative, leveraging Energy Service Companies (ESCOs) can be considered for financing smart home technology in Kazakhstan. ESCOs can become key players in the market providing advanced smart solutions with flexible financing. This not only benefits consumers by ensuring energy and cost savings but also fuels business innovation. The collaboration with ESCOs might prove to be an effective tool in achieving a sustainable and technologically progressive future in Kazakhstan, enhancing both individual lifestyles and overall business dynamics.
The success of ESCOs is, however, currently contingent upon the establishment of fair tariff structures and thus, allows for limited economic viability.

Sources: [46] Tengrinews.kz, 2023. [47] Kursiv.kz, 2023.

Case of Brazil – successful network and IoT development

Brazil's digital transformation, marked by USD 1 billion government investment and private sector incentives, offers a compelling blueprint for Kazakhstan's development, given their vast territories[48]. In Brazil, household internet access has risen from 30.7% to nearly 60% for fixed broadband and 92% for mobile internet[49], driven by tax incentives that motivated private companies to invest in the country's internet infrastructure. The National IoT Plan, shaped by 2,300 public contributions, serves as a strategic framework propelling Brazil's IoT industry[50].
It emphasises a structured approach, innovation across sectors, and prioritises national solutions. A collaboration with the World Economic Forum yielded a Protocol for Action supporting small and medium-sized manufacturing companies in Brazil to adopt IoT. Tested in sectors like aeronautics and automotive, the protocol demonstrated 21.6% average increase in operational efficiency and over 192% return on investment[51]. Brazil's smart home potential has surged with improved internet access and enabling regulations. The growing presence of affordable smart home devices and the rise of ambient computing contribute to the increasing popularity of IoT appliances, providing advantages for local players. Respective regulation ensures standardisation, interoperability, and privacy through a mandatory certification process, addressing concerns in the evolving smart home landscape.

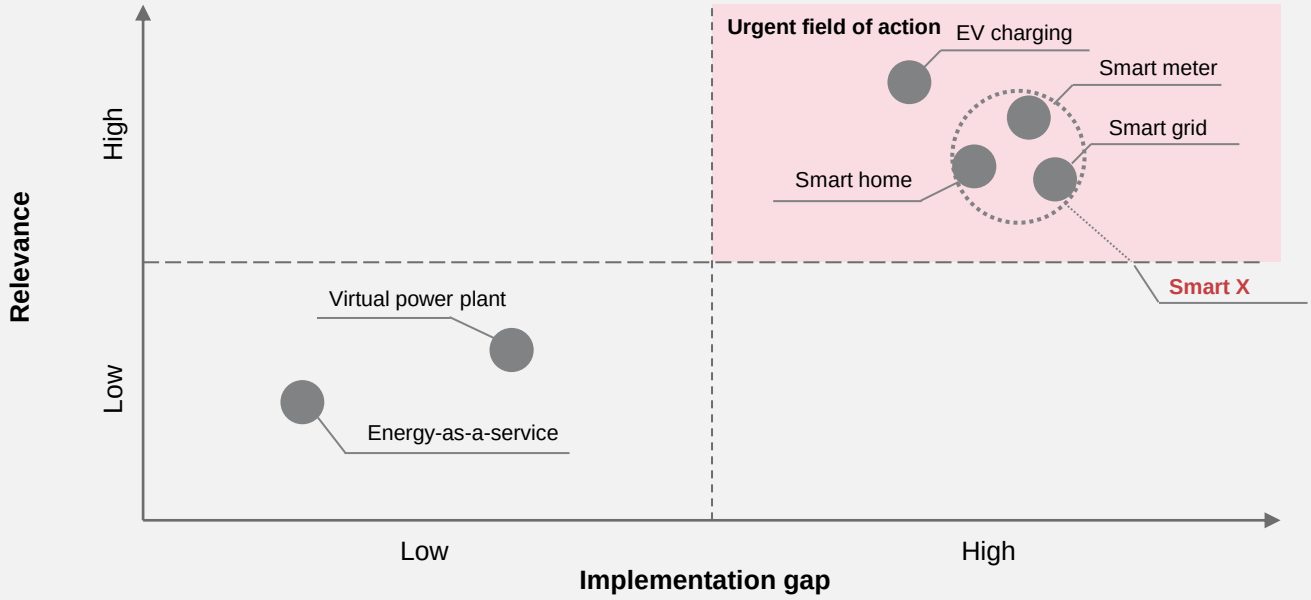
Sources: [48] Tech in Brazil, 2017. [49] Tech in Brazil, 2017. [50] Tech in Brazil, 2017. [51] World Economic Forum, 2023.

3. Implementation gaps and recommendations in Europe

3.1. Exploring the implementation gap in digital business models: European utilities

As *Exhibit 13* below shows, there is currently a gap between the DBM's expected relevance to the potential revenue generation in the future and the current degree of implementation for the utility companies in (predominantly) Europe. The size of the gap between the two measures indicates how much companies still must do to build a business model with a profitable income stream in the future.

EXHIBIT 13
The implementation gap



Source: Strategy& analysis

Undoubtedly, DBMs offer an attractive new investment option for utilities, in particular those DBMs with a large implementation gap, which includes the smart DBMs described above (smart home, smart metering and smart grid) as well as EV charging.

Using the data and flexibility that smart DBMs create to offer adaptable pricing can set up valuable business opportunities. One example is that renewable electricity production happens at irregular intervals when the sun shines, with no solar energy produced during the night. However, many EV drivers choose to charge their cars overnight, implying utilities need to buy expensive energy storage to hold and then supply the power generated by solar at night, or invest in further production capacity. Consumers at present have no incentive to change their charging routine, but by offering adaptable electricity prices that are lower during times when renewable production is high (and electricity prices low), consumers can be incentivised financially to charge their car at those times of the day instead. This type of flexibility makes consumers financially better off and helps energy companies win new consumers and save on their energy storage investment cost.

> Integrating renewable energy is inevitable in transitioning our energy system. This requires a more flexible energy system, i.e., remote control of energy production, transmission, distribution, storage and consumption. A widespread application of such a digital business model is, however, yet to be established in Germany."
>
> **Constantin Eis,**
> **CEO at LichtBlick SE (major German energy supplier)**

So why do these implementation gaps exist? The survey across utility companies in Europe made for this Study shows the reasons fall into two broad categories:

1. Economic uncertainty makes financial payoffs unclear

The world economy has been hit by several large and unforeseeable shocks in recent years. This has hampered investment as establishing a novel DBM becomes much riskier in an uncertain and volatile environment of economic downturns (technical recession in Germany), rising geopolitical tensions (the war in Ukraine), disruptions in the regulatory landscape (the gap between climate change pledges from different states versus actual regulations to tackle emissions), and technological disruption (battery EVs versus hydrogen fuel cell engines as long-term solution, for example). These risk factors make financial payoffs for digital business model investments more uncertain (51 percent of survey respondents agreed), and companies' timelines for digital transformation unclear (45 percent agreed).

> A changing economic and political environment has certainly contributed to the observed underinvestment in digital business models. To make the digital transformation a real success story, DBMs must be built to be resilient to such external shocks."
>
> **Dr. Marcus Eul,**
> **Managing director and partner at Strategy&**

However, uncertainty is not going away, making business model resilience through adapting fast to significant shifts in the economy essential. First, a portfolio of innovative services and products will be hit less strongly by economic shocks, and second, building an entrepreneurial and agile culture enable companies to adapt faster to the needs of a dynamic environment.

2. Poor access to capital also contributes to the funding gap

A difficult funding situation is the second factor driving the implementation gap. Some 55 percent of respondents attributed poor access to capital and 46 percent of respondents attributed a lack of internal understanding of DBMs as two major hurdles.

We believe the time has come for companies to raise significant external funding to set up their DBMs if they are serious about these products and services accounting for close to half of revenues in ten years' time. The reality is that the funding requirements are enormous. On average, survey respondents estimated that the annual funding required to fully scale DBMs add up to 12 percent of annual sales. That compares with net margins in the energy industry that are on average well below 10 percent (without considering the recent price shock effects caused by the war in Ukraine) meaning that investments the size of companies' entire annual profits are required for the successful implementation of digital business models. Several levers exist to improve this funding situation.

Funding gap?

55%

attributed poor access to capital

46%

attributed a lack of internal understanding of DBMs

Firstly, utilities can build a portfolio of minority investments to familiarise themselves with the opportunities and challenges related to the new DBM or technology they are considering building. They can then use what they learn to help leadership teams select better projects and focus on the right strategic areas.

How the minority investment approach works at Shell

Shell Ventures, a subsidiary of Royal Dutch Shell, makes minority investments into new technologies and disruptive digital business models that accelerate the energy and mobility transition. This portfolio approach allows Shell to test various DBMs and technologies and identify the most promising. For instance, the company increased its investment into Sonnen to 100% in 2019, expanding its offering of residential smart energy storage and energy services.

Secondly, utilities can look to secure more funding from investors or government grants and subsidies. To win new investors it is key to make the investment opportunity more appealing, i.e., business cases will need to show a clearer route to profitability. Also, government grants are yet readily available, for instance, the EU has identified the lack of investment in digital business models and set up several funding programmes in response, including the Digital Europe Programme, the Connecting Europe Facility, InvestEU, Horizon Europe and Creative Europe.

Making government funding work for DBMs

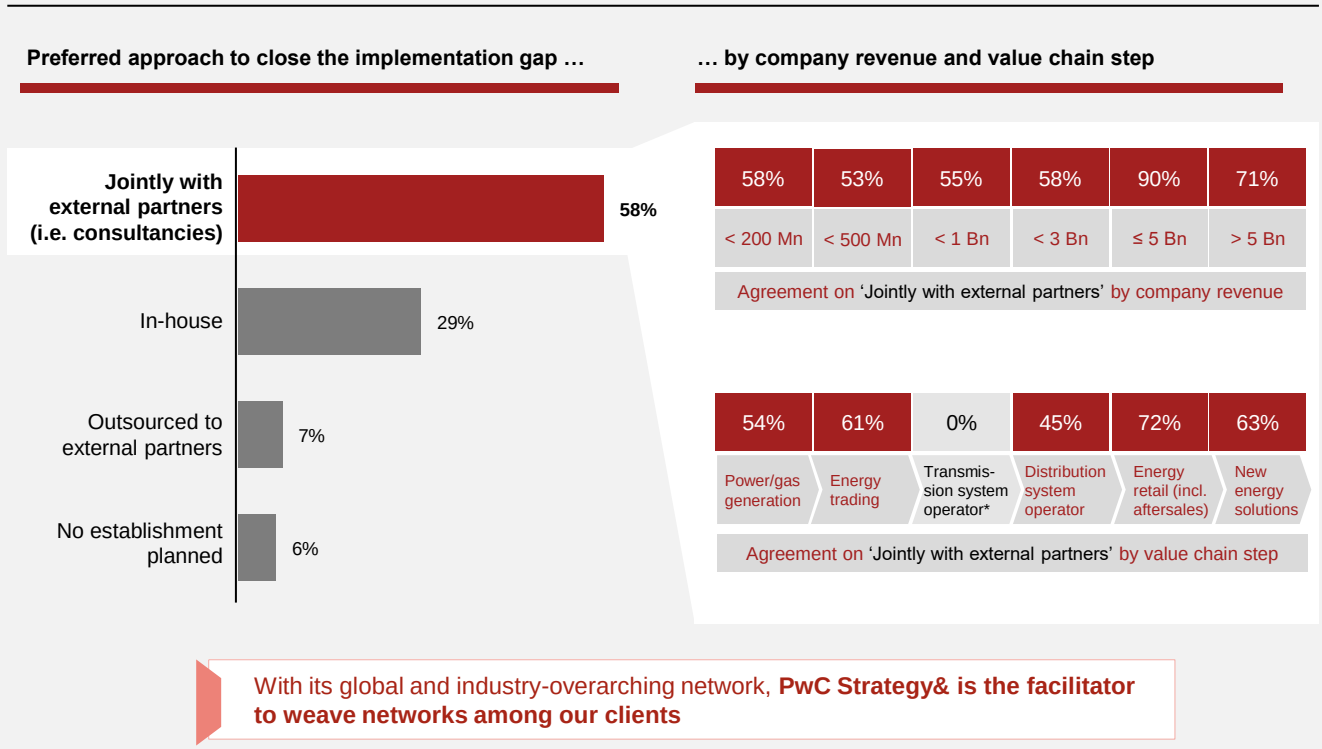
A prominent example of a company receiving low interest government loans is Tesla. Back in 2010, Tesla received a USD 465 million loan from the U.S. Department of Energy (DOE) as part of the Advanced Technology Vehicles Manufacturing (ATVM) Loan Program. This funding played a significant role in the expansion of Tesla’s electric vehicle lineup and the development of its digital and autonomous driving technologies.

3.2. Matching relevance with reality: How to bridge the implementation gap

While recommendations in this section are primarily developed for European utilities, they offer valuable insights for Kazakhstani companies. However, significant efforts are required for the initial implementation of smart grid, EV charging, and smart home technologies before such recommendations can be implemented in Kazakhstan (see recommendations for Kazakhstan on pp. 28-37).

The companies in Europe of all sizes and across the entire value chain identify partnerships as the most promising route (*see Exhibit 14*). Some 58 percent of respondents agree that only "jointly with external partners" can the full potential of DBMs be reached.

EXHIBIT 14
Partnerships are seen as the most promising way to close the implementation gap



With its global and industry-overarching network, **PwC Strategy& is the facilitator to weave networks among our clients**

* Only n=1 and thus inadequate number of interview partners from a TSO company interviewed
Source: Strategy& analysis

E.ON is just one of many good examples how to enable DBMs jointly with external partners. The utilities started a partnership in Germany with Google's parent company Alphabet and the technology company Tetraeder in 2018[52], offering its customers a digital assessment of the potential when adding solar panels to their homes. The service considers various data points including weather data, the position of the sun in different seasons, the area and pitch of the roof as well as the shade of surrounding buildings or trees to calculate how much sunlight falls on the roof. E.ON then translates that number into energy and potential cost savings from their solar panels offering. This example shows how partnerships with technology leaders can contribute to digitalising existing business models.

Sources: [52] E.ON, 2017.

> Enormous potential lies in leveraging the know-how of technology leaders and integrating it in an DBM. I believe that existing large players will not develop innovative and digital solutions on their own. They will rather orchestrate the different service providers and to align their unique technologies in new solution."

Kevin Bär,
VP global sales at E.ON One of E.ON Group (German energy supplier)

However, Strategy& survey suggests that closing the implementation gap to establish a successful DBM also requires companies to invest in the necessary internal capabilities and technology.

Access to IT experts identified as first priority in capabilities

According to survey respondents, the most important capability to build is internal IT expertise, by hiring the right skilled workers with state-of-the-art tech backgrounds. Other capabilities including customer understanding, regulatory knowledge or clear strategic focus and steering were viewed as less essential.

Although the utilities sector has faced skills shortages in the past, this time is different because companies are competing with other industries for the same specialised talent. Unless power companies become more attractive as employers, winning the war for talent and implementing successful DBMs will remain a challenge.

> If relevant forecasts are correct, it can be assumed that the demand in practice for qualified business information technology talent will continue to grow as a result of the digitalisation of business and administration."

Univ.-Prof. Dr. Armin Heinzl,
Universität Mannheim

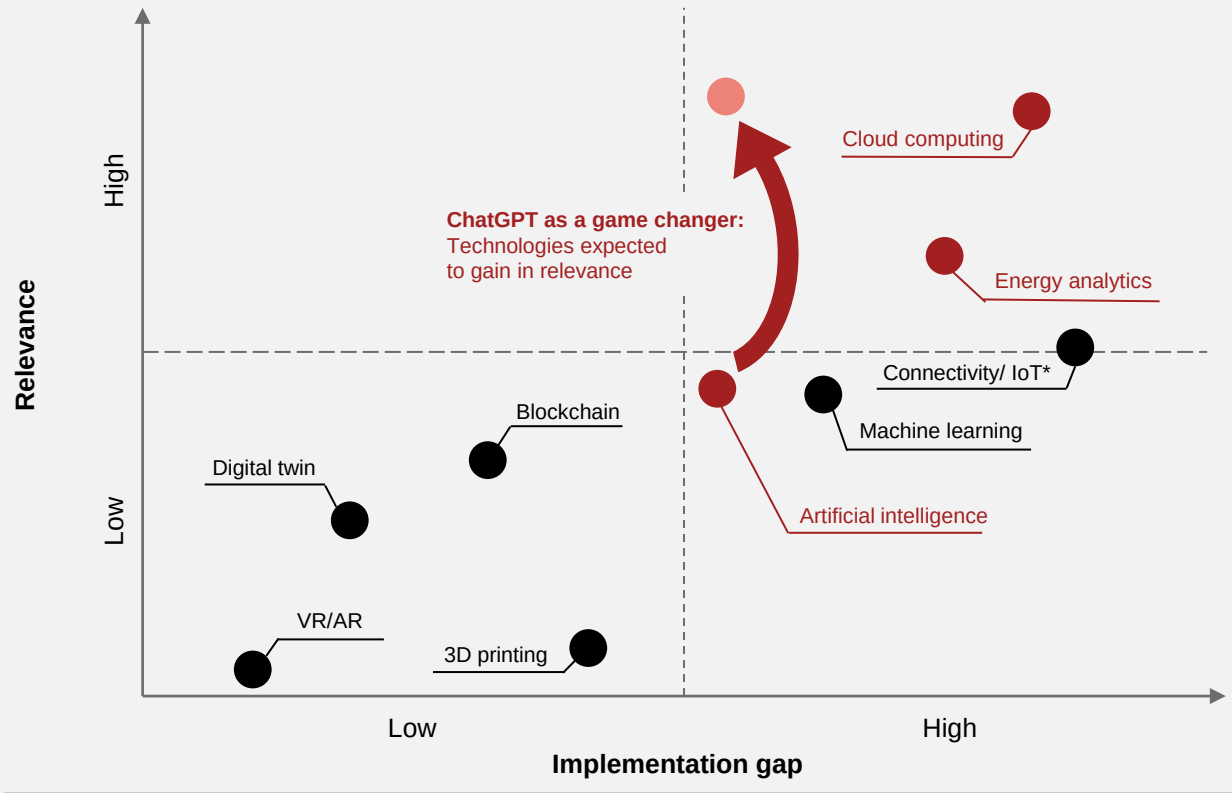
We suggest the following approaches to overcome the shortage of skilled workers with IT knowledge:

- Appoint a chief digital officer to lead digital transformation efforts.
- Target recruitment of IT experts specialised in digitalisation and automation, exploring near-or offshore options to attract top talent from international markets given shortages in western countries including Germany.
- Implement internal schooling and education programmes for IT, data analysis and AI skills.
- Establish collaborative partnerships with universities and research labs to recruit talented individuals through internships and research projects.

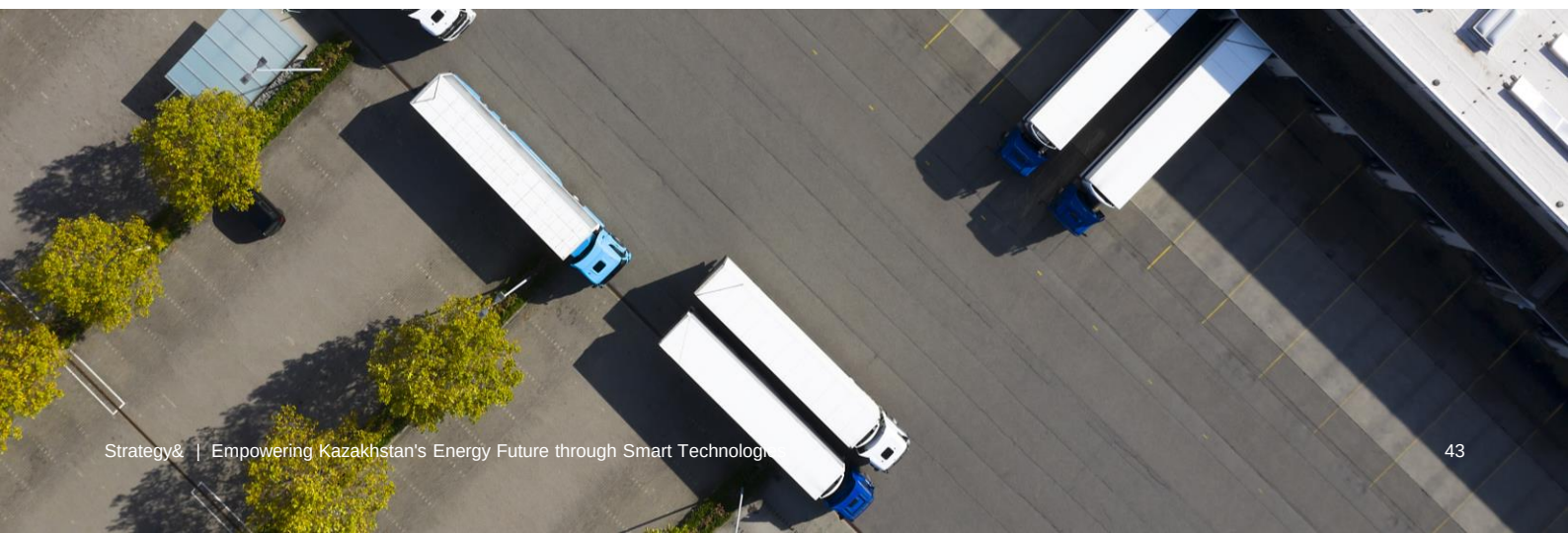
The key technologies to enable digital business models

The right technologies are the key enablers for DBMs, offering the framework that facilitates the development of innovative ideas, finding new opportunities and exploring new ways of doing business.

EXHIBIT 15
Relevance and degree of implementation per key technology



*IoT: Internet of Things; VR: Virtual Reality; AR: Augmented Reality
Source: Strategy& analysis



Strategy& survey shows that utilities lack a thorough understanding of some of the most important technologies, with respondents indicating limited application within their organisations (see Exhibit 15, previous page). Specifically, energy analytics (utilising advanced analytical models to derive new insights from energy data) and cloud computing (providing faster innovation, flexible resources, and economies of scale through internet-based computing services) are deemed highly relevant and crucial for the success of DBMs. However, companies struggle to effectively apply these two technologies in practice as shown by their low degree of implementation. This highlights the urgent need for improvement. The relevance and limited application to date were mentioned by subject matter experts in the interviews Strategy& carried out alongside the survey:

> Energy analytics and cloud computing are already among the most important and disruptive technologies in the energy sector. In addition, the recent success of ChatGPT has highlighted the potential of AI, i.e., AI is likely to become the most important technology in the future. However, companies need to learn how to use these technologies in their daily work before they can develop into successful DBMs."
>
> **Jan-Wilm Buschkamp,**
> **Chief information officer at Mainova AG (German energy supplier)**

Energy analytics at work in the real world of smart grids

Dutch grid operators run together the platform GOPACS, which aims to ensure grid stability in the most cost effective manner. An increasing share of renewable energy generation and greater electricity demand requires the grid to be expanded, but that cannot happen over night. To buy time, GOPACS applies technology to forecast potential grid congestion and makes use of flexibility provided by energy market participants to prevent the congestion from happening. The energy analytics technology used by GOPACS allows low rebalancing costs and reduces the pressure for grid expansion to happen immediately.

We further want to note that the survey was conducted before ChatGPT started its triumphant march highlighting the potence of generative AI. Potentially, our respondents are thus likely to assess the relevance of AI as much higher today than observed. We see, among other, two main fields of application for generative AI in the energy sector.

1. Forecasting analytics

Generative AI is a form of artificial intelligence that focuses on creating new content by learning from existing data patterns. It is especially useful for the energy industry, which relies on complex data analysis, pattern recognition, and forecasting. With increasing renewable energy usage and unpredictable weather, traditional forecasting methods are no longer practical. Generative AI becomes thus a valuable solution to tackle these challenges effectively. For example, Gridmatic, a California based company, has been founded on exact this basis in 2017. It is an AI-enabled power marketer that aims to increase profitability of renewable energy generators, optimise revenues from storage and lower costs of energy consumers.

2. Personalised customer experience

Energy companies are currently lagging behind in utilising data to enhance customer service. However, with the potential of generative AI, they can revolutionise the customer experience by tailoring content to individual needs. A few examples illustrate this: Firstly, by generating customised energy usage reports, energy companies can aid customers in reducing their consumption. Secondly, by implementing chatbots, they can efficiently address customer billing questions. Lastly, through analysing past purchases and browsing history, generative AI can offer personalised recommendations for products, services, and content. For instance, if a customer has recently purchased a smart thermostat, they might receive valuable recommendations for a solar panel installation or a home energy audit.

On a final note, it is however important to state that leading industry players have already recognised the necessity for this technological transition and, as a matter of fact, have initiated their transitional journey. Anna Jasper-Martens from E.ON emphasises this as follows:

> Already now, we at E.ON embrace data analytics and sophisticated deep learning models to augment our core processes and establish new services at scale. The heat transition denotes only one prominent use case that will only be successful if energy companies and municipalities harness the power of digital technologies within the infrastructure planning process."

Anna Jasper-Martens, CEO E.ON Infrastructure Solutions Germany

Conclusion

According to Strategy& analysis, in 10 years, digitally enhanced products and purely digital content are expected to make up 45 percent of utilities revenue, close to double the 24 percent proportion today. DBM will provide a complementary value add to the existing core business instead of fully replacing it. The most promising DBMs include EV charging and smart DBMs such as smart homes, metering and grid, where the latter provides flexibility options to the energy system. However, smart DBMs are also among the least mature, holding considerable commercial potential for utilities in the future.

This study examines the current implementation status of smart grid, EV charging, and smart home technologies into the Kazakhstan's energy system. Our analysis reveals a considerable implementation gap across all three sectors. While certain smart grid technologies have seen partial adoption within the grid, there remains substantial ground to cover. The coverage of EV charging infrastructure is certainly insufficient, mainly concentrated in two major cities, and poses a challenge to accommodate the rapid growth of EVs. Additionally, smart home technologies, despite their potential for growth, remain underutilised among households.

While assessing the current state of technology implementation, we have identified significant barriers impeding their widespread adoption. In the areas of smart grid and EV charging, key obstacles include the absence of a clear regulatory framework providing guidance for all stakeholders, coupled with insufficient financial investments crucial for grid infrastructure modernisation and charging station installation. Additionally, smart grid deployment faces challenges stemming from insufficient stakeholder engagement between the groups, considering the diverse entities involved. Furthermore, hurdles in smart home implementation encompass inadequate network development level, limited support for local company technologies, and negative stakeholder attitude.

Our recommendations to tackle these challenges draw upon international best practices. We have showcased how leading nations formulated their standards and regulations, highlighted initiatives and practices fostering the widespread adoption of smart grid technologies, EV charging infrastructure, and smart home technologies. Additionally, we have provided examples of available software technology in Kazakhstan that could optimise the implementation of these technologies in the future. Addressing identified challenges with consistent and comprehensive strategy involving implementation standards and procedures and subsidising the adoption of EV charging and smart technologies are considered as the first and major step for Kazakhstan on the way to the digitalisation of the energy industry.

Next steps would then involve what Strategy& Study survey respondents agree on as the most promising way to kick-start DBMs: First, improve your access to external funding by identifying more lucrative investment opportunities through a better understanding of digital business models. Second, collaborate with external partners to leverage their technological knowledge. Third, built up internal IT knowhow to be able to tackle the challenges of the digital transformation. Fourth, put in place the necessary digital capabilities, including cloud computing, energy analytics and AI, that will enable their chosen digital business models to reach their full potential.

The valuable insights shared by the European utility companies in the Strategy& Study serve as a guiding reference for local authorities and businesses as we navigate our own path to more resilient and sustainable energy system. The transformation will lead to innovative legal frameworks; increase in investments into infrastructure and new technologies is inevitable.

Glossary

AC – Alternative Current

AI – Artificial Intelligence

AIX – Astana International Exchange

AMI – Advanced Metering Infrastructure

APFC – Automatic Power and Frequency Control

API – Application Programming Interface

ASKUE (АСКУЭ) – Automatic System for commercial accounting of power consumption

DBM – Digital Business Model

DC – Direct Current

DER – Distributed Energy Resources

DMS – Distribution Management System

EBRD – European Bank for Reconstruction and Development

EMEA – Europe, Middle East, and Africa

ESCO – Energy Service Company

ESO – Energy Supply Organisation

EV – Electric Vehicle

FACTS – Flexible Alternating Current Transmission System

GHG – Greenhouse gas

HEMS – Home Energy Management System

HVDC – High Voltage Direct Current

ICE – Internal Combustion Engine

IoT – Internet of Things

KASE – Kazakhstan Stock Exchange

KEGOC – Kazakhstan Electricity Grid Operating Company

ML – Machine Learning

NB IoT – NarrowBand IoT

REC – Regional Electricity grid Company

RES – Renewable Energy Sources

R&D – Research and Development

SCADA – Supervisory Control and Data Acquisition

SGMM – Smart Grid Maturity Model

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Study Authors:

PwC: Natalya Lim, Timur Yeginzhanov, Saniya Begenova, Dana Turgali, Diana Khussainova, Zhazira Zhanadilova, Ruslan Dosmaiyl.

PwC Contacts:

Natalya Lim
Partner, Advisory Services
natalya.lim@pwc.com

Timur Yeginzhanov
Director, Advisory Services
timur.yeginzhanov@pwc.com

Please send inquiries regarding the study to:

Saniya Begenova
Manager, Advisory Services
saniya.b.begenova@pwc.com

Dana Turgali
Associate, Advisory Services
dana.turgali@pwc.com

Diana Khussainova
Associate, Advisory Services
diana.khussainova@pwc.com

PricewaterhouseCoopers Tax & Advisory LLP
Al-Farabi Ave 34, Building A, Floor 4, Almaty, Kazakhstan, A25D5F6
T: +7 (727) 330 32 00, F: +7 (727) 244 68 68, www.pwc.kz